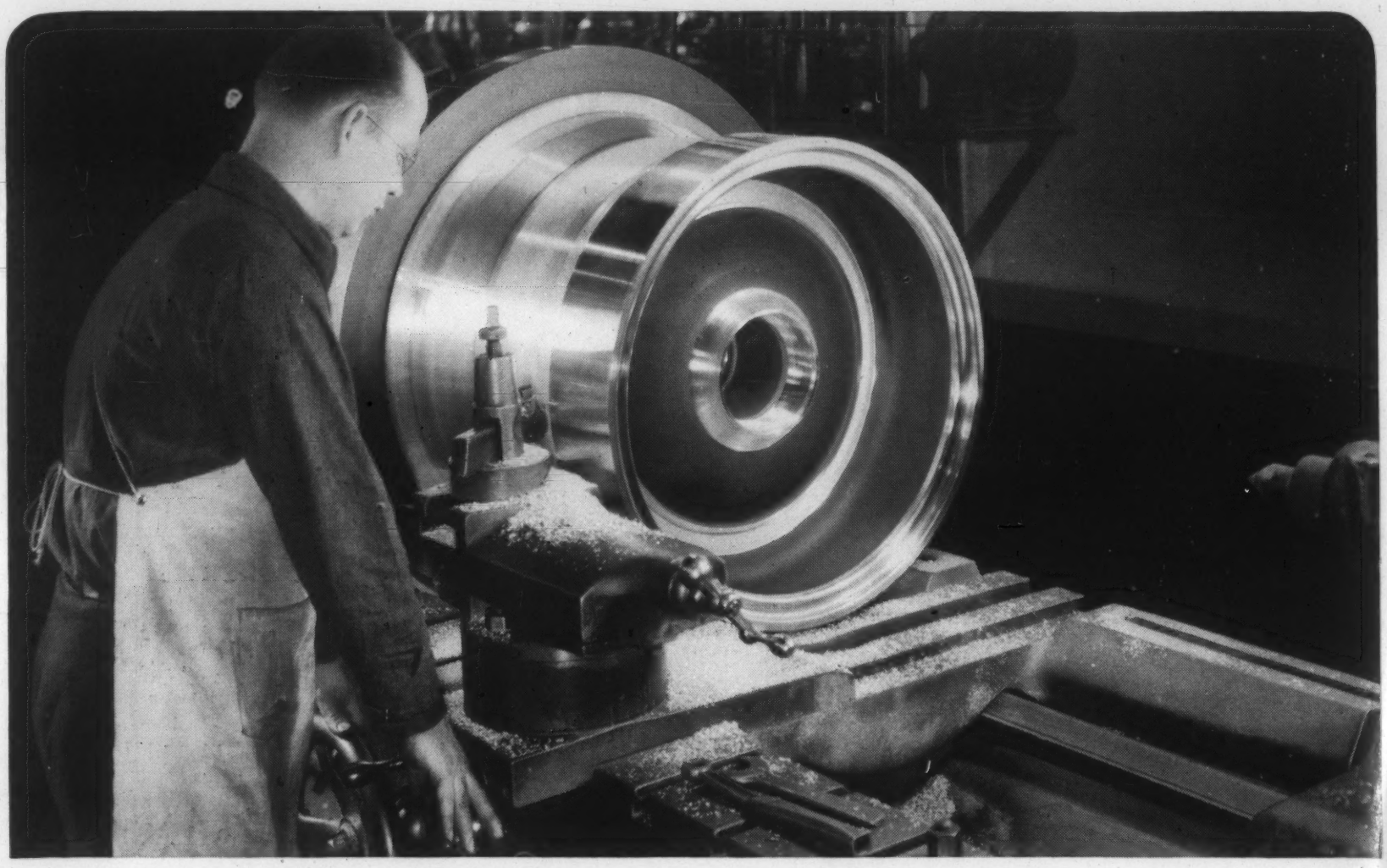
Metals and Alloys

THE MAGAZINE OF METALLURGICAL ENGINEERING

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

JULY 1941

DOWMETAL MAGNESIUM



MUCH EASIER TO MACHINE

DOWMETAL* Magnesium Alloys are easier to machine than any other common metal. Practically all machine tools can be run at their maximum speeds and with feeds to the full capacity of the machine. In general, the following advantages over other industrial metals are gained:

(a) Higher cutting speeds; greater feeds and deeper cuts; (b) Smooth finish readily attained without drag or tear; (c) Less power for equal volume of metal removed; (d) Easier handling of parts due to low weight; (e) Less wear on machining equipment.

Information on all phases of machining magnesium alloys is available and should be consulted previous to operations.

*Trade Mark Reg. U. S Pat. Off.

21.6.

MAGNESIUM AND DEFENSE

If you are having difficulty in securing all the magnesium you need, please remember this metal is vital to your country's defense. Dow is providing vastly increased production facilities for magnesium which will be available to all industry at the earliest possible moment.

Working with you for America

THE DOW CHEMICAL COMPANY
MIDLAND MICHIGAN

New York City, St. Louis, Chicago, San Francisco,
Los Angeles, Seattle, Houston

CASTINGS • FORGINGS • SHEET • STRIP • PLATE • EXTRUSIONS

TRADE MARK
DOWMETAL
MAGNESIUM ALLOYS

LIGHTEST OF ALL STRUCTURAL METALS

E. Engin. Lib.

East Engin. Library

VOLUME 14 • NUMBER 1 • JULY, 1941

Metals and Alloys

H. W. GILLETT, Editorial Director
Battelle Memorial Institute, Columbus

EDWIN F. CONE, Editor

FRED P. PETERS, Associate Editor

DORIS MCYNIHAN, Assistant Editor

Advisory Board

H. A. ANDERSON
Western Electric Company

WILLIAM BLUM
Bureau of Standards

A. L. BOEGEHOLD
General Motors Corporation

P. H. BRACE
Westinghouse Electric & Mfg. Co.

G. H. CLAMER
Ajax Metal Company

JUNIUS D. EDWARDS
Aluminum Company of America

O. W. ELLIS
Ontario Research Foundation

H. J. FRENCH
International Nickel Company, Inc.

JOHN HOWE HALL
Consultant

S. L. HOYT
Battelle Memorial Institute

J. B. JOHNSON
Wright Field Air Corps, War Dept.

JOHN JOHNSTON
United States Steel Corporation

JAMES T. MACKENZIE
American Cast Iron Pipe Company

R. F. MEHL
Metals Research Laboratory, C.I.T.

W. B. PRICE
Scovill Manufacturing Company

LEO F. REINARTZ
American Rolling Mill Company

H. A. SCHWARTZ
Nat'l. Malleable & Steel Castings Co.

F. N. SPELLER
Consulting Metallurgical Engineer

JEROME STRAUSS
Vanadium Corporation of America

Published Monthly by Reinhold Publishing Corporation, East Stroudsburg, Pa., U.S.A. Ralph Reinhold, President and Treasurer; H. Burton Lowe, Vice President and Secretary; Philip H. Hubbard, Vice President; Francis M. Turner, Vice President. Executive and Editorial Offices, 330 West 42nd Street, New York. Price 25 cents a copy. Annual Subscription: U. S., Possessions and Canada, $2.00. All Other Countries, $3.00. (Remit by New York Draft.) Copyright, 1941, by Reinhold Publishing Corporation. All rights reserved. Entered as second class matter June 12, 1934, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.

Articles

Producing Continuous Butt-Welded Pipe 31
L. J. HESS

Beryllium as a Light Metal Component 37
C. B. SAWYER

Production of "Silvery Pig Iron" 40

Electrolytic Manganese Alloyed with Copper ana Nickel—II 47
B. L. AVERBACH

"Chrom-X" and our Chromium Problem 52
MARVIN J. UDY

Hydrogen in Steel and Cast Iron—IV 56
C. A. ZAPFFE AND C. E. SIMS

Recovery of Indium From Waste Liquors 60

Manufacturers' Literature 18
Highlights 27
Editorial 29
News 63
Shop Notes 73
Books 120
Advertisers in This Issue 124
Trends 126

Metallurgical Engineering Digest

Production 80
Processing and Fabrication 89
Design and Applications 102
Testing and Control 114

Feature Section

Continuous Butt-Welded Pipe

The latest information on Bethlehem's continuous process and equipment for making butt-welded steel pipe from skelp is offered in our first article.

Beryllium-Aluminum Alloys

Supplementing an article on this subject, published in our June 1940 issue, Dr. Sawyer discusses some of the latest developments in this field and brings the subject up to date.

Making "Silvery Pig Iron"

An impressive pictorial presentation of some of the important steps in the production of silvery pig iron constitutes our third article.

Alloys of Manganese with Nickel and Copper

The second and last part of the discussion on high resistance alloys of the new product, electrolytic manganese, with copper and nickel, brings this important treatise to a close.

Chromium from Low Grade Ores

Commercial ferrochromium is made largely from high-grade chromium ores. A major portion of these ores is imported. "Chrom-X," the subject of our fifth article, is a comparatively new and important product, made from low-grade domestic chrome ores, and of vital interest strategically. Its manufacture is described.

Hydrogen in Steel and Cast Iron

The last of the 4-part article on this subject by two experts in this research concludes this important discussion. It has both technical and practical value, particularly as regards the effect of hydrogen on coatings of enamel.

Indium

A method of recovering indium from waste liquors is briefly presented in our concluding article. There are many times when such a procedure has decided practical value.

Engineering Digests

Pound-Wise Refractory Use

The use of super-duty fireclay brick in melting furnaces, although entailing a small increase in original-refractory cost, effects overall economy because of its longer life as compared to high-heat-duty refractories, avers Swain (page 80).

Hard Chromium Plating Made Easy

Detailed instructions for preparing and operating baths for electrodepositing hard, wear-resistant chromium surfaces on molds, dies, gages, etc. are given by Yates (page 89).

Underwater Cutting and Welding

European ship-repair yards have doubtless had to do considerable plain and fancy patching below the water-line in the last year or so. We can probably, therefore, class as authoritative a German author's practical pointers on underwater cutting and welding (page 92).

Furnaces are Faster

New furnace installations that feature shorter cycles or greater production rates are described, together with modern atmosphere-generating systems, in a "composite" on page 95.

Oils vs. Bearing Metals

An oil man (Pigott, page 106) has some hard words about automobile-bearing design, and implies that the corrodible bearings (cadmium-silver and copper-lead) have caused more trouble than they're worth.

"Twin-Six" High Speed Steels

The tungsten supply situation is accelerating the trend away from 18-4-1, toward high speed steels of the "Mo-Max" type. An interesting compromise is cited by Allen (page 110)—a 6 per cent Mo, 6 W, 4 Cr, 1.5 V steel with some good properties borrowed from the older steels plus a few of its own.

New X-Ray Technique

A new X-ray inspection technique, involving ionization of air by means of X-rays, is being regularly applied for inspecting soldered joints, report Woods & Kenna (page 114).

GOOD NEWS!

FOR USERS OF RESISTANCE WELDING

SWEEPING PRICE REDUCTIONS ON IGNITRON TUBES

As a result of wide-spread acceptance and increased use, we announce a reduction in prices on our improved line of stainless-steel ignitron tubes, effective immediately.

With both inner and outer shell of corrosion-proof steel, G-E ignitron tubes offer resistance-welding users greater economies and performance capacity than ever before.

Full information on how these tubes can help improve *your* welding profits is readily available from our local office. Or write to General Electric, Schenectady, N. Y.

Types	Old Price	New Price
FG-258A	$295	$250
FG-235A	$140	$110
FG-271	$75	$55

1941

Type FG-271 All-metal

New low price $55

Demand current,
10% duty cycle = 830 amp

1936

Type FG-179 Glass

Price $290

Demand current,
10% duty cycle = 560 amp

GENERAL ELECTRIC

Side-Blow Converters

Twenty-five or more years ago the small side-blow (or Tropenus) converter was a major factor in the production of steel castings. Due to many causes—economic and metallurgical—its use was gradually displaced by the electric furnace. In those earlier days there were about 100 converters; now there are not many more than one-fifth of that total.

In these days of high pressure demand for steel and of fantastic proposals for increasing our capacity, it is encouraging to note that the return of the converter is in sight. Testimony at the recent convention of the A. F. A. was to the effect that there is increased interest in this efficient melting unit and that orders for installations are on the increase.

Conditions surrounding the operation of the small converter are quite different now from what they were a quarter of a century ago. It is now possible to eliminate high sulphurs with alkali treatment, the electric eye is now available for more accurate regulation of the blow, refractories have been improved so that their life is longer to the great advantage of the converter in reducing blowing losses, an all-scrap charge in the cupola can be handled, and the cost of electric power in some localities has become a factor.

Properly manipulated there is no question but that high quality steel can be made in the side-blow converter. Its come-back seems assured under present conditions. It should be a potent factor in the Defense Program.—E.F.C.

"Information Please"-- in Steel

An innovation in the character of technical sessions was inaugurated and tried out at the 50th General Meeting of the American Iron and Steel Institute in New York in May. Instead of the usual presentation of pre-printed technical papers before a sparse hearing, the idea of a question and answer program was carried out. From some 300 questions submitted by Institute members, 19 were selected for the session. To answer these questions, 19 operating and metallurgical engineers prepared answers which were read by the authors. Under the excellent direction of Quincy Bent, vice president in charge of production of the Bethlehem Steel Co., who added spice to the affair by propounding a surprise question to each participant, some of whom were "stumped," the session was one of the most interesting and successful in the Institute's history. While some of the questions and answers covered ground familiar to many, the general result was the dissemination of knowledge and of facts of signal benefit to the large audience. The experiment will certainly bear repeating.—E.F.C.

Japan and Our Scrap Steel Exports

In an editorial—"Scrap Iron and Steel for Japan" —in our August, 1939 issue, page 258, we called attention to the vast amount of scrap iron and steel which had been and was being sent to Japan. The data there presented showed that from 1933 to April 1, 1939, inclusive (6 yrs. and 3 mos.) we had exported about 14,514,000 gross tons of scrap iron and steel, of which approximately 7,772,400 tons or 53.5 per cent went to Japan, according to U. S. Government data.

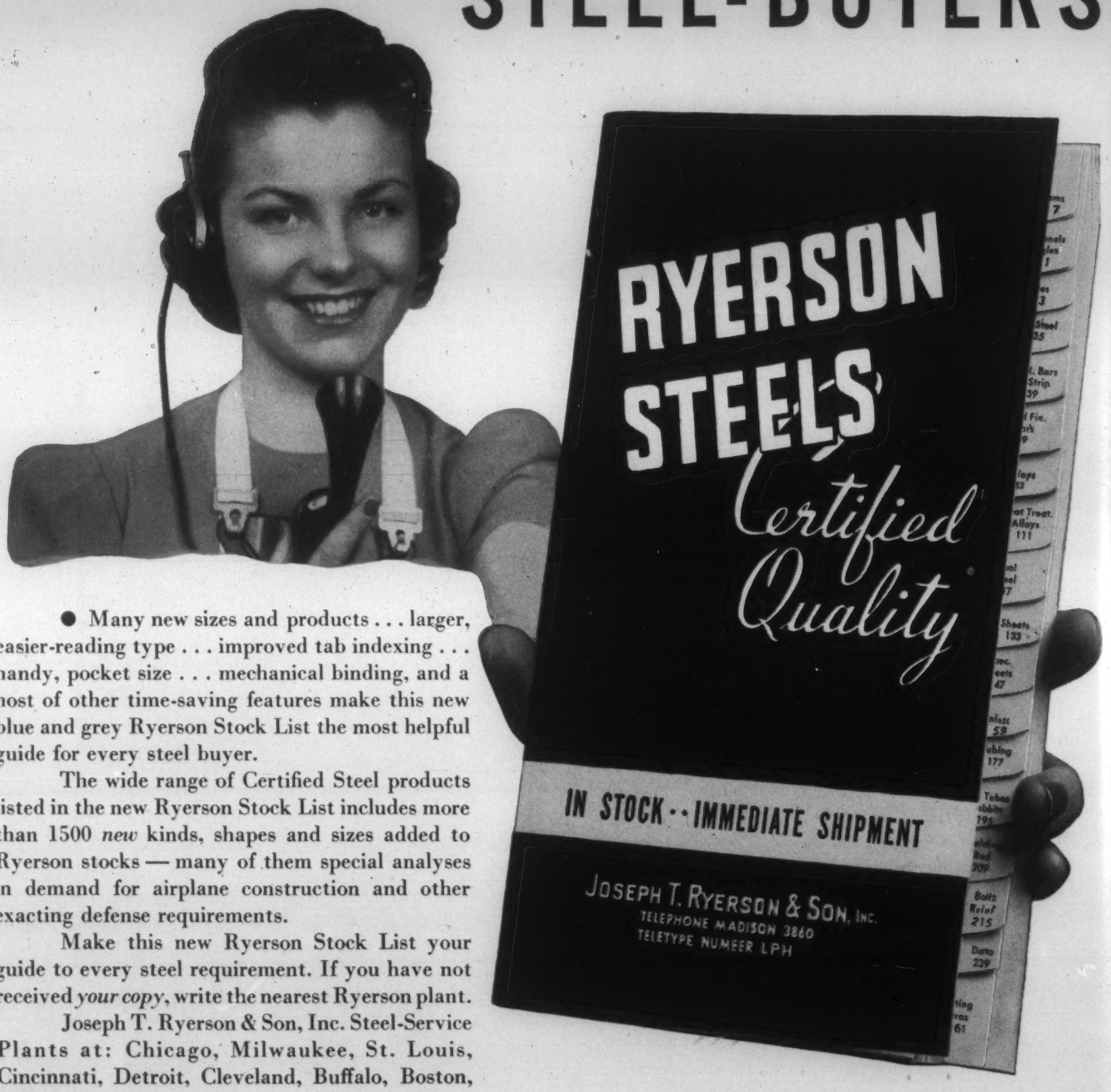
Bringing these data more nearly up to date, we find that from 1933 to 1939 inclusive, or 7 yrs., our total scrap steel exports were about 17,326,300 tons of which 9,272,800 tons were sent to Japan. Here again the percentage sent to that country was 53.5 per cent for the 7 yrs. In 1940 the exports, while large at 2,823,100 tons, were more widely distributed, only 963,500 tons, or 33 per cent going to Japan. This year, due to embargoes and other war developments, the outgo has been drastically cut. To April 1, the total was only 173,816 tons with the small quantity of 289 tons sent to Japan! This is as it should be.

In the editorial referred to we raised the question:

> Whether or not we are partly exhausting our supplies of scrap steel and copper, the situation should be studied by Washington, and in the interests of peace and humanity, possibly some limit set on such exports or an embargo to nations at war, actual or undeclared.

No one could then visualize the situation we are in today—millions of tons of steel needed for National Defense and Aid-to-the-Democracies, with scrap iron and steel in insufficient supply. We store manganese, tungsten, chromium, etc.—perhaps we should have stored some of the scrap which the Japanese have converted into battleships and guns to shoot at the Chinese and possibly eventually at us! Part, at least, of the 20,300,000 tons exported since 1933 would be a boon now to the production of tanks, armor plate, guns and battleships.—E.F.C.

New Guide for STEEL-BUYERS



● Many new sizes and products . . . larger, easier-reading type . . . improved tab indexing . . . handy, pocket size . . . mechanical binding, and a host of other time-saving features make this new blue and grey Ryerson Stock List the most helpful guide for every steel buyer.

The wide range of Certified Steel products listed in the new Ryerson Stock List includes more than 1500 *new* kinds, shapes and sizes added to Ryerson stocks — many of them special analyses in demand for airplane construction and other exacting defense requirements.

Make this new Ryerson Stock List your guide to every steel requirement. If you have not received *your copy*, write the nearest Ryerson plant.

Joseph T. Ryerson & Son, Inc. Steel-Service Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON *Certified* **STEELS**

RYERSON CERTIFIED STEELS

Producing Continuous Butt-Welded Pipe

by L. J. HESS

Superintendent Pipe Mills, Bethlehem Steel Co., Sparrows Point, Md.

The manufacture by the Bethlehem Steel Co. at its Maryland plant of continuous butt-welded pipe from skelp is described in this article. The first unit of this new mill was completed early in 1940. Since then a second and larger unit has been added. In its construction and operation the company has incorporated data and experience gained since the first unit was built. The article is therefore the latest word concerning this interesting and important operation.—The Editors.

PRODUCTION OF BUTT-WELDED PIPE by the continuous process has been carried out at the Maryland plant of Bethlehem Steel Co. for over a year. The first unit, producing sizes from 3/8 to 3 in. diameter, was placed in operation in January last year. In July, it was followed by a second unit, for sizes from 1 to 4 in., nominal inside diameter.

Except for the difference in the size of pipe rolled, the two units are similar in design and operation. Briefly described, each unit consists of an electric flash welder with plow trimmer, in which the outside end of the incoming coil of skelp is butt-welded to the trailing end of the preceding coil, thus permitting continuous operation. To prevent any stop in the operation during flash welding, a double looping bed is provided immediately after the welder.

From the looping bed the skelp passes into a long, gas-fired heating furnace where it is brought to welding temperature. Leaving the furnace it is immediately fed into six roll passes, three horizontal and three vertical roll pairs. The first of these takes the place of the forming bell in the old type butt-welding mill, and the actual welding takes place in the second roll pair. The last four passes furnish the traction necessary to pull the skelp through the furnace. To intensify the heat at the weld and to blow off scale, a blast of air is directed against the edges of the skelp as it emerges from the furnace.

A flying hot saw following the welding rolls cuts the pipe into prescribed lengths, which then go through the customary scale breaking and straightening rolls to a cooling table. The finishing operations are similar to those of the conventional butt-welding mill.

Skelp Supplied in Coils

Skelp for the smaller, No. 1 unit is supplied in coils of 35 to 48 in. diameter, 185 to 750 ft. long, weighing from 600 to 2400 lbs. This unit is designed to roll skelp from 0.068 to 0.312 in. thick, 1½ to 12 in. wide, in rates up to 16 tons per hr. The larger, No. 2 unit rolls skelp 6 to 16 in. wide, up to 0.380 in. thick, supplied in 30 to 44 in. diameter coils weighing 900 to 2500 lbs. each, and measuring from 150 to 400 ft. in length. Based on standard 4-in. pipe, the rated capacity is 25 tons per hour.

As the mill has been in operation for more than a year the initial difficulties encountered in practically every new process have been eliminated, and the operations have become well standardized.

The operation is continuous in the true sense of the word, as the skelp moves through furnace and welding stands and is formed into pipe without interruption until it is cut to length. To insure smooth,

The welding rolls and hot saw of the continuous butt-welding units at the Maryland Plant of the Bethlehem Steel Co.

A close-up view of the hot saw in the continuous butt-welding unit.

continuous flow of the skelp, sufficient space must be provided on the looping beds to allow for the time required in the flash welding operation.

Coils of skelp are delivered from storage, weighed, and placed in the coil box of the welder. The skelp is passed through a roller leveller into an up-cut shear which trims the end of the coil when necessary. It is then located in the welding jaws, abutted to the trailing end of the preceding coil, and the weld is completed in 3½ to 17 sec., according to the size of the skelp. After a short pause to allow the weld to cool somewhat, the flash is removed with a plow type trimmer.

No. 1 unit has a primary loop of 162 ft. and a secondary loop 55 ft. long. For unit No. 2 the corresponding figures are 150 and 35 ft., respectively. As it is not practical to locate the flash welder too close to the furnace, the available loop which may be drawn into the furnace during the welding operation is 250 to 300 ft. With a running speed of 350 ft. per min. this gives less than a minute for locating the last end of the coil in the welding jaws, feeding the incoming end of the next coil through the leveler and locating it in the welder, making the weld, and finally trimming the flash.

The looping beds are at the floor level and are paved with granite blocks to give them good resistance to wear. To keep the skelp moving, a pinch roll is provided between the primary and the secondary loop. The action of the pinch rolls is controlled by a pair of limit switches, actuated by the secondary loop, to maintain this loop at constant length.

Any false move during the welding cycle may result in a slowdown, and on the smaller sizes this means a shut-down, as the skelp will generally burn through if the speed of travel is stopped for any length of time. Experience shows that about 80 per cent of all shut-downs can be traced to difficulties in the flash welding cycle. The welding machine is also subjected to a continuous shower of fine scale cracked loose by the leveller, which may cause short circuits or give sluggish air control. Constant vigilance and thorough training of the welding personnel are essential to maintain uninterrupted operation of the mill.

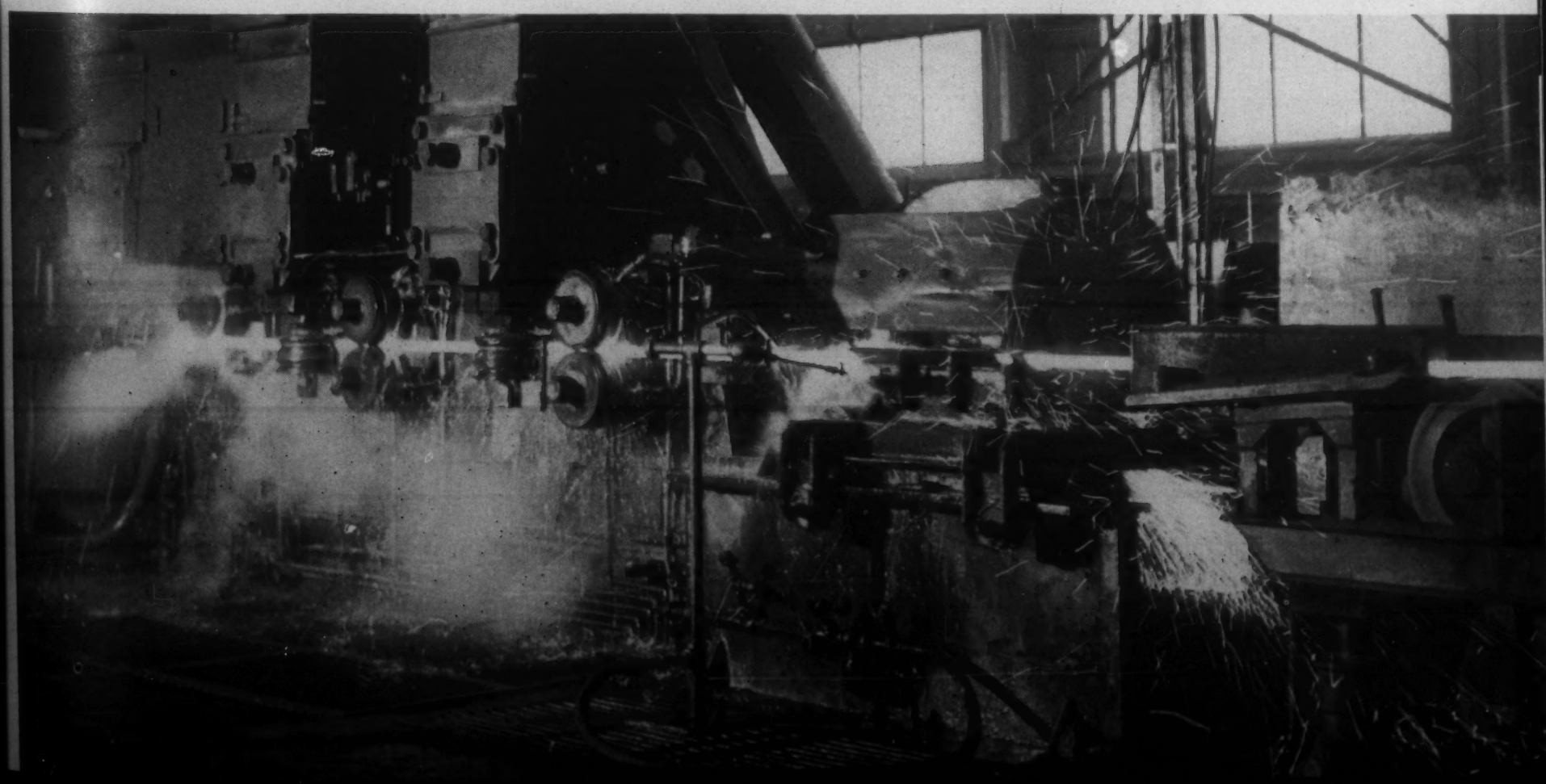
The Heating Furnace

The heating furnace is really the heart of the mill and presents many interesting features. It consists of a long, narrow heating chamber, 21 in. high, 27 in. wide at the top and 18½ in. wide at the bottom, divided into a short preheating zone and three heating zones equipped with a large number of nozzle-mixing burners spaced at 9-in. centers. The principal dimensions of the two furnaces are as follows:

Furnace		No. 1	No. 2
Preheating zone		29 ft., 6¼ in.	15 ft., 10¾ in.
Heating Zone	No. 1	45 ft., ¾ in.	54 ft., 10¾ in.
	No. 2	36 ft., 4 in.	45 ft., 5 in.
	No. 3	35 ft., 2 in.	39 ft.
Total length		146 ft., 1 in.	155 ft., 2 in.
No. of burners	No. 1	104	132
	No. 2	88	110
	No. 3	82	92
	TOTAL	274	334

The burners are arranged in groups of 11, connected to a common header. Each burner has a small gas cock and a blast gate for adjusting preheated air, permitting a wide range of flame adjustment. This gives very accurate control of the heating operation, and also makes possible a high heat release in the furnace, as high as 95,000 B.t.u. per hr. per cu. ft. of furnace volume. Burner capacity ranges

A close-up view of the welding rolls in the continuous butt-welding unit.



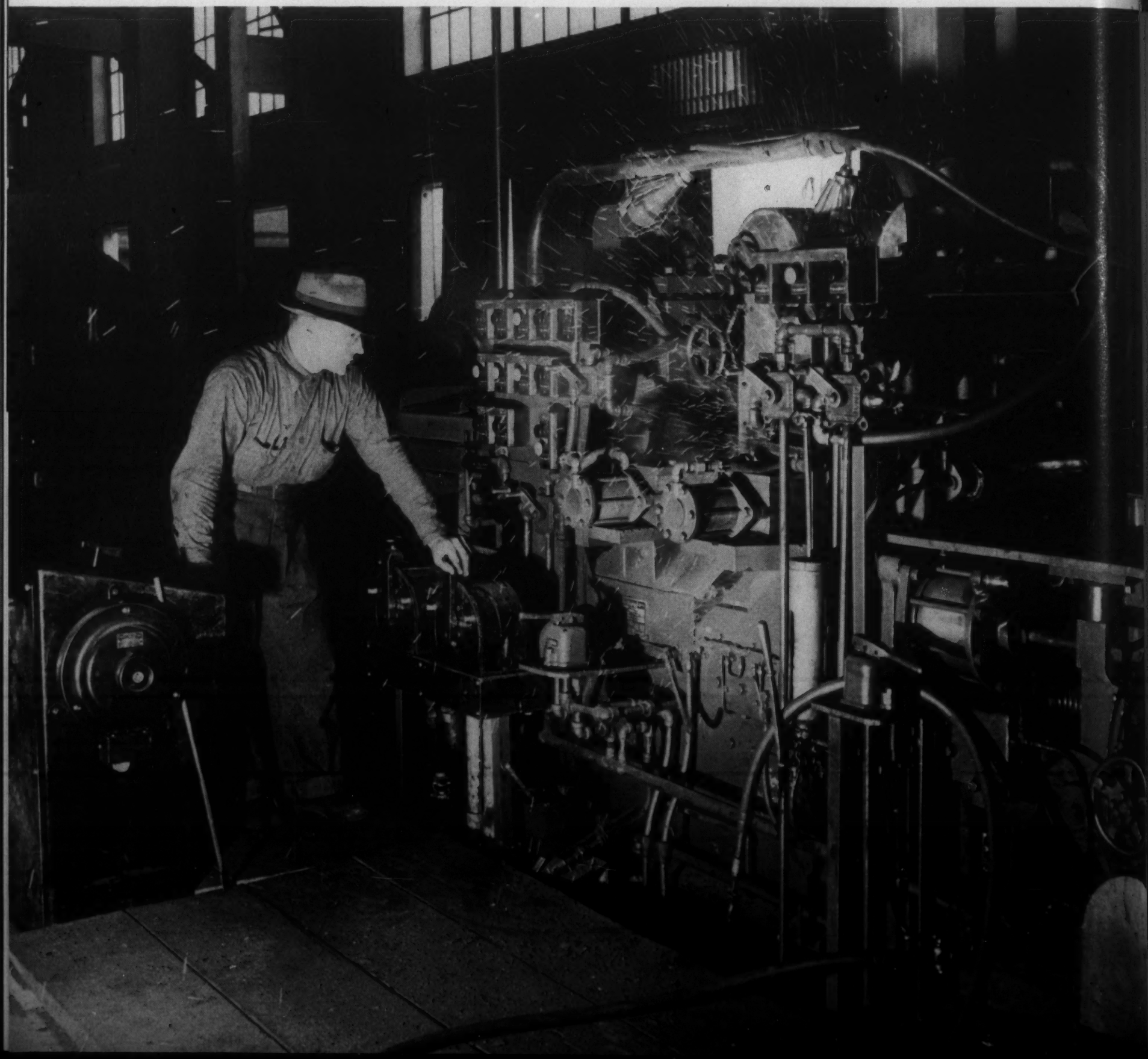
from 80,000 to 145,000 cu. ft. of gas per hr., for a mixed gas of 500 B.t.u., delivered to burners at 4 to 8 oz. pressure with the air pressure of 4 oz.

As the skelp passes through the furnace, the flames from the long row of burners impinge directly upon the edges, which are quickly brought to welding temperature, that is, close to the softening point. The central portion of the strip, however, does not reach this temperature and consequently retains sufficient mechanical strength to withstand the pull exerted by the welding rolls as these draw the skelp through the furnace. This condition differs radically from that encountered in the conventional furnace used in heating cut lengths of skelp. The close control of the heating operation, with the flames impinging on the edges of the skelp, and the comparatively short heating time insure high uniformity of the weld, with minimum of waste and scaling loss. The average production characteristics of the furnaces are as follows:

Furnace No.	Diam. of pipe, in.	Speed, Ft. per min.	Time in furnace, min.	Gas consumption, Cu. Ft. per Hr.
1	½	368	0.397	80,000
1	1¼	247	0.592	115,000
2	1½	238	0.654	120,000
2	4	95	1.635	143,000

In the preheating zone the skelp is carried on three alloy steel rolls, equipped with individual chain and sprocket drives to prevent stopping of all rolls in case of chain failure. In the heating zone the skelp slides on 12 water-cooled skid pipes which can be removed and replaced without stopping the mill. This method of supporting the skelp prevents

The electric flash welder in the continuous pipe mill.



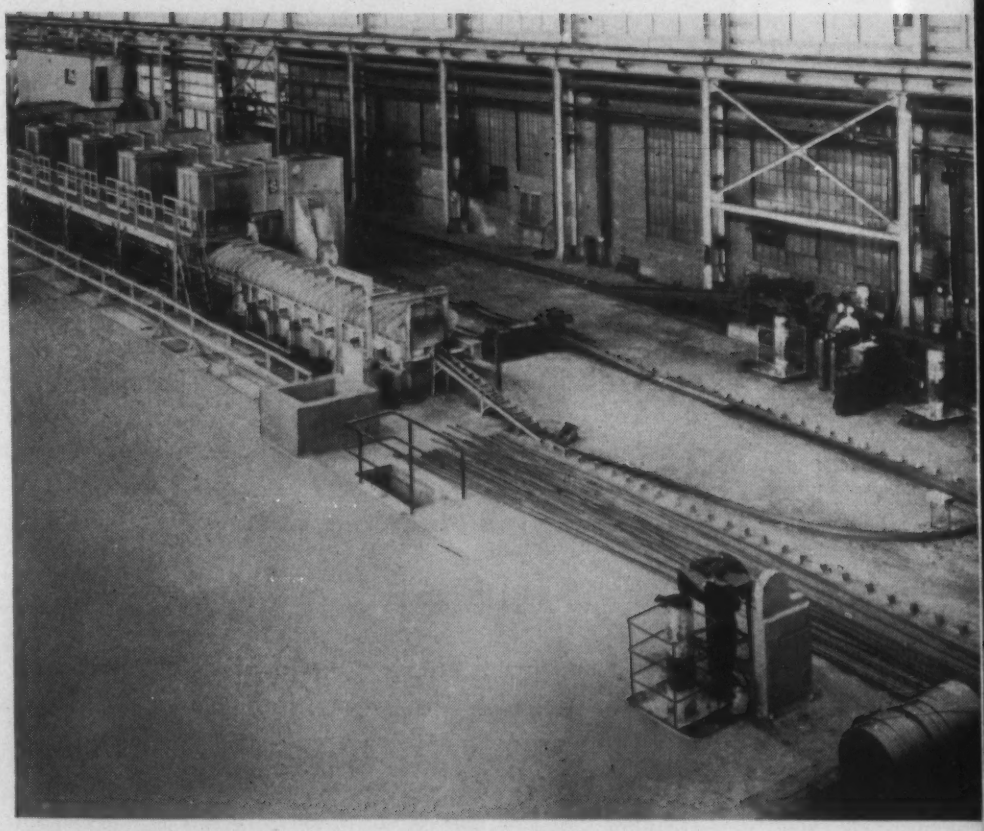
The cooling table in the butt-welding mill.

contact with furnace walls and hearth.

The furnace is enclosed on the sides in ¼-in. steel plates braced with 6-in. I-beam buck stays. Side walls are of 13½-in. high quality fire brick backed with a graduated amount of insulation. The bottom is made up of 4½ in. of plastic chromite, 15½ in. of fire brick and 3 in. of graduated insulation. For removal of slag and scale the hearth slopes sharply toward the clean-out doors which have been provided at regular intervals. In the coldest part of the furnace the scale is easily removed with hoe and bar. Towards the discharge end it becomes sticky and more difficult to handle. In the hottest zone the scale will usually run and can be tapped out, especially if finely broken cast iron is occasionally thrown in.

Refractory Problems

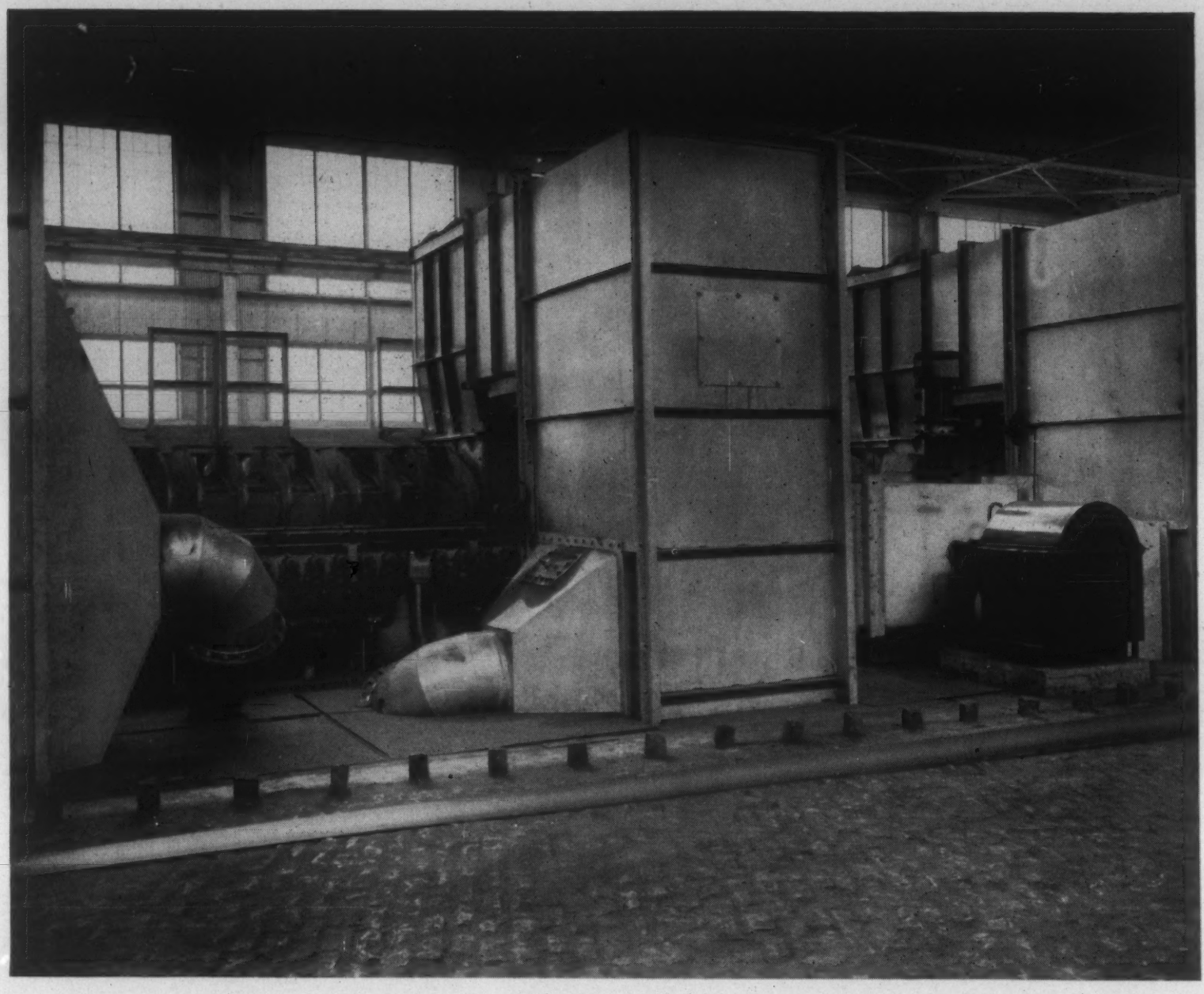
Due to the peculiar construction of the furnace the refractories are subject to intense heat, combined with the erosive action of the high velocity gases carrying scale from the moving skelp. The section immediately ahead of the exit must also resist flying scale propelled by the air blast applied to the edges of the skelp as it emerges from the furnace. As a result the average life of the burner blocks and the furnace lining in the hottest zone is about nine weeks. A continuous study is being made of the refractory problem. Best results are obtained by operating continuously from rebuild to rebuild. If it can be avoided a furnace should never be allowed to cool off during the life of a lining.



The charging end of the heating furnace.

The Flying Hot Saw

As the pipe leaves the welding rolls it passes a flying hot saw where it is cut into uniform lengths. The saw traverse is driven by the welding mill motor and is synchronized with the speed of the pipe. Proper maintenance of the saw is of great importance, as uniform cut lengths are imperative. To operate with a tolerance of ½-in. plus or minus the



Recuperators for preheating the air for combustion.

mechanism must function with a timing variation no greater than 1/72 of a second for the highest mill speed. Every part must function properly while exposed to heat, water and flying scale. This requires rigid inspection at frequent intervals and replacements at the least sign of wear.

From the saw the cut lengths pass over a cooling rack of the chain and sprocket type and then to a sizing mill and de-scaler where the scale is cracked loose both from the inside and the outside, and the final size obtained. This is followed by a second cooling rack, whereupon the pipe is ready for the regular finishing operations.

As proper heating is essential, the furnace is equipped with an elaborate system of controls. Each of the three heating zones is connected to the main gas supply through a double diaphragm valve. One controlling potentiometer connected to a thermocouple in the furnace roof, near the discharge end, operates all three diaphragm valves. The flow of gas is automatically controlled, in accordance with the temperature changes at the furnace thermocouple. Simultaneously the air supply is regulated to maintain a predetermined air-fuel ratio. Any one or all three of the heating zones may also be manually controlled, if desired.

Recuperators for Heating Air

Measured quantities of combustion air are preheated to 900 deg. F. in six recuperators, equipped with tubular silicon carbide elements. The preheated air is delivered by fans to the headers of the respective zones. Thermocouples in the outlet ducts from each fan are connected with potentiometers which record and control the maximum temperature of the preheated air. Cold air is automatically admitted if the temperature in any ducts should exceed the prescribed figure.

The gases of combustion pass through an underground flue leading to an ejector stack outside the building. An automatically controlled damper in the stack maintains a furnace pressure of approximately 0.13 in. of water.

by C. B. SAWYER
President, Brush Beryllium Co., Cleveland

Beryllium As A Light Metal Component

This article supplements one by Dr. Sawyer published in our June 1940 issue, page 163. It adds information of value to that and also brings certain phases of the important discussion up to date. For full clarification the article last year should be consulted.—The Editors.

VERY LITTLE SUCCESS has resulted from efforts to alloy magnesium with beryllium, as anything exceeding 1 or 2 per cent of magnesium is apparently rejected as vapor, while the beryllium is solidifying at its melting point approximating 1280 deg. C. Somewhat related difficulties attend efforts to alloy aluminum with beryllium, though at least here there is no trouble from vapor phases.

The constitutional diagram for the two metals shows a very wide range of solidification beginning with the melting point of beryllium and extending to about 20 deg. below the melting point of aluminum where the eutectic is formed. This eutectic contains only a fraction of a per cent of beryllium as shown by Archer and Fink[1], while at the beryllium-rich region of the diagram we have not been able to produce any solid solution of aluminum in beryllium approximating the 8 per cent called for by the commonly given constitutional diagram[2] (Fig. 1). If a solid solution exists, it probably contains less than 1 per cent by weight of aluminum. The situation, therefore, is not the most fortunate for producing sound billets for either hot or cold work.

In order to have the two metals alloy in the liquid state, it is necessary to use temperatures which are far beyond those healthy for aluminum. Consequently, gas is readily absorbed and acts as a source of most of the ills commonly associated with it in metals.

This all condenses into the statement that though it is quite possible to produce ingots large enough for experimental determination of the properties of beryllium-aluminum alloys, it has not yet been possible to go much beyond this laboratory operation. Some results on cast beryllium-aluminum, which have been obtained by J. B. Johnson, chief, Materials Laboratory of Wright Field, in cooperation with our company, were given earlier.[3] To these data on 28 per cent Al, balance Be (25,000 lbs. per sq. in. tensile, 19,000 lbs. per sq. in. yield strength, 3 per cent elongation) may now be added the endurance value, 11,000 lbs. per sq. in. at 20 x 10^7 cycles. This as-cast structure at 500 dia. shows the eutectic surrounding grains of beryllium. The same condition exists in as-cast alloy containing only 5.5 per cent of aluminum and even only 1.25 per cent of aluminum; but when this latter alloy was soaked for 6 hrs. just below the eutectic temperature and quenched, the strings of eutectic were changed into islands. (Micrographs of these structures were shown in the earlier account.[3]) The fact, however, that the eutectic still persisted challenges the existence of the solid solution shown in the diagram, as earlier commented upon.

For the past four or five years, the Aluminum Co. of America, in cooperation with J. B. Johnson of Wright Field and the Brush Beryllium Co. of Cleveland, has been carrying out an extensive investigation of beryllium-aluminum alloys aimed at the production of a better piston material. Some of the results obtained are of interest as shown in the Table.

In general, the strengths of wrought binary alloys at a definite elongation are 10,000 to 30,000 lbs. per sq. in. below those of the strong aluminum-base alloys used in aircraft when the alloys are compared at the same value of elongation. The higher modulus of elasticity of the beryllium-aluminum alloys is much in their favor, but cannot overcome this disadvantage where ductility is important. Moreover, their creep strength (not shown in the table) is very low. Even at the low stress of 5,000 lbs. per sq. in. binary beryllium-aluminum sheet showed over four times as much creep as duralumin alloy at five times the stress.

Patents broadly covering beryllium-aluminum alloys[4, 5] expired in the last decade, but so far as is known, the Table constitutes the first publication of

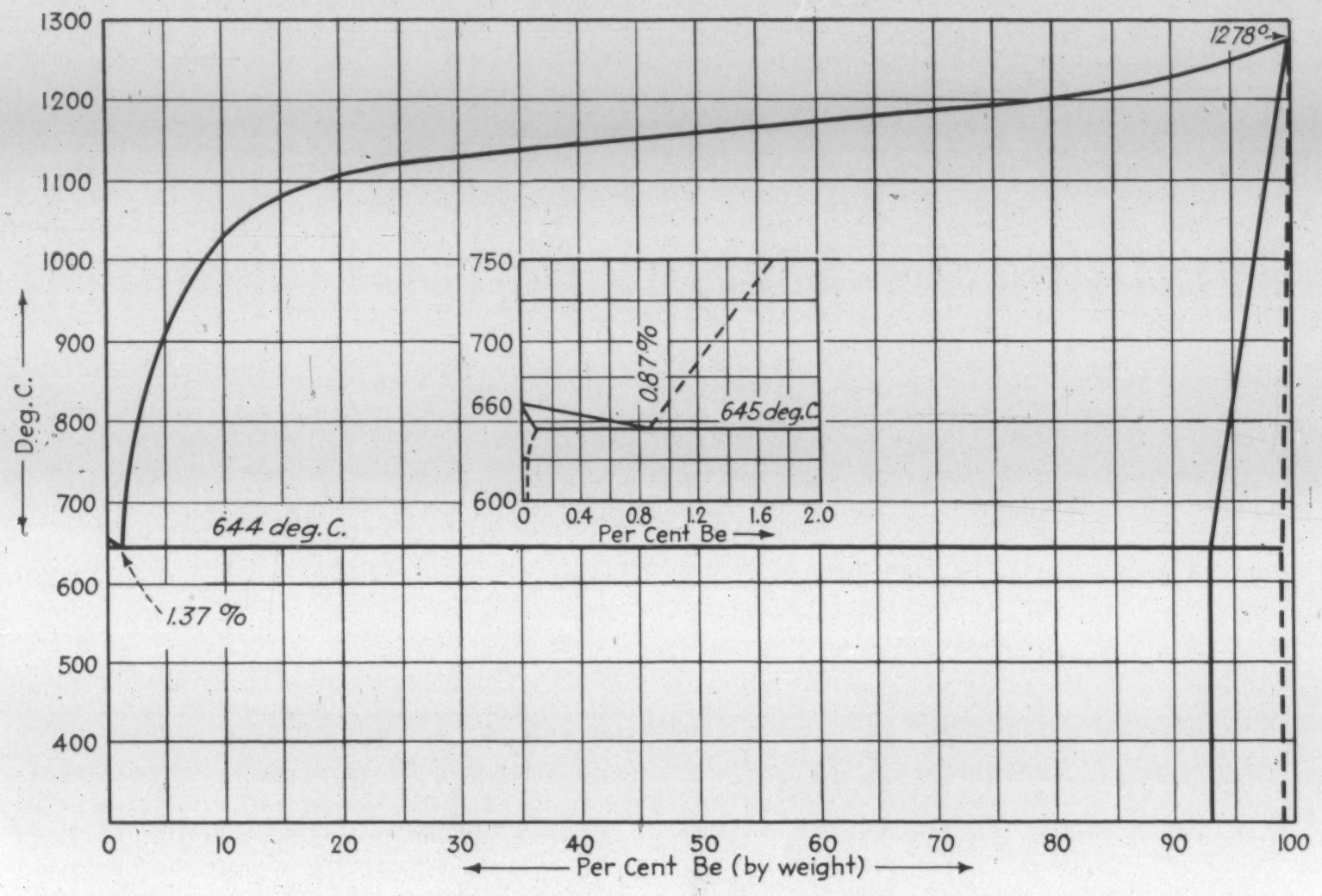


Fig. 1. Oesterheld's original constitutional diagram of beryllium-aluminum; insert of aluminum end, by Archer and Fink; dotted solubility line of beryllium end sets maximum limits.

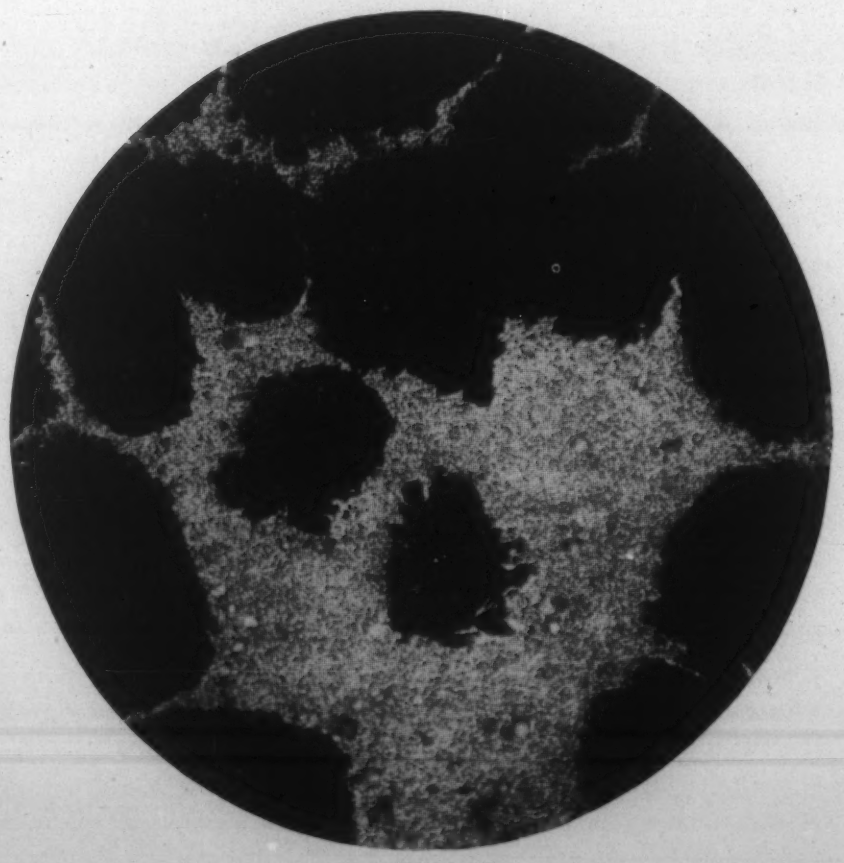


Fig. 2 Structure of a 50% Be-Al-Cu alloy with added components vacuum melted. Etched 10 min. in 2 per cent HF. 400 X.

their mechanical properties.

The binary alloys can be improved by adding other components (see bottom of the Table); and probably this would aid the creep strength, perhaps even making it normal. But as in the case of binary alloys, those which have considerable elongation have only high modulus to make them attractive. This statement concerns their properties at room temperature. At 600 deg. F., as may exist in a piston, these alloys have higher endurance limits and much higher tensile strength than the materials now in use, and therefore hold out attractive possibilities if they can be made. Unfortunately, almost two years of co-operative work has resulted in only one article which looked like a piston, and that probably could not get by an aviation inspector at a distance less than 6 ft.

So, except for limited applications which can be made on material from a laboratory scale of production, we have to conclude that beryllium-aluminum alloys are not now a factor.

Beryllium-aluminum polynary alloys often show the beryllium grains etching dark where the binary alloy would show light beryllium. This is shown (Fig. 2) at 400 diameters for a 50 per cent Be alloy. This as-cast sample was prepared by melting in an

X-ray vacuum, but even this does not seem to solve the problems of working the metal.

A possibly interesting small use for beryllium in aluminum-base alloys is found in the claim that in quantities of about 0.005 per cent, it restrains oxidation of the molten alloy and refines the grain.[6] Similar quantities added to magnesium-base alloys have been found to increase the corrosion resistance of such alloys.[7]

References

[1] R. S. Archer and W. L. Fink. *Trans. Am. Inst. Mining Met. Engrs., Inst. Metals Div.*, 1928, page 616.
[2] G. Oesterheld. *Z. anorg. allgem. Chem.*, Vol. 97, 1916, page 6.
[3] C. B. Sawyer and B. Kjellgren. METALS AND ALLOYS, Vol. 11, June 1940, pages 163-167.
[4] H. S. Cooper. U. S. Patent No. 1,254,987 (Jan. 29, 1918).
[5] F. A. Fahrenwald. U. S. Patent No. 1,333,965 (Mar. 16, 1920).
[6] Compagnie Alais, Froges et Camargue. French Patent No. 832,821 (Oct. 4, 1938).
[7] B. Wullhorst. *Mitt. Forsch.-Inst. Probieramts Edelmetalle*, Aug. 1939, pages 16-25.

Table of Mechanical Properties of Binary Aluminum-Beryllium Alloys (Aluminum Co. of America)

Be, per cent	Form	Temper	Tensile strength, lbs. per sq. in.	Yield strength, lbs. per sq. in.	Elongation, per cent	Hardness, BHN	Young's Modulus $\times 10^6$	Red. of area, per cent	Elec. Cond.	Fatigue: Load	Fatigue: Cycles $\times 10^6$
9.8	Sheet	50% Reduction	35500	33900	2.8	...	....	....	....	.....	.....
9.8	Sheet	Quenched, 562° C.	22100	10300	25.5	...	....	....	....	.....	.....
16 *	Sheet	50% Reduction	39100	37200	2.0	...	....	....	....	.....	.....
16 *	Sheet	Quenched, 562° C.	26400	12700	19.5	...	....	....	....	.....	.....
19.94 [1]	Extruded	As-extruded	20800	10900	17.0	41	16.2	15.5	....	.....	.....
19.94	Extruded	Tested at 600° F.	6620	4150	25.0	...	12.6	33.4	....	.....	.....
22 *	Forged	⅜-in. Bar	28000	18000	4.5	62	20.0	10.5	....	.....	.....
22 *	Forged	⅜-in. Bar	35000	20000	9.5	70	....	....	....	.....	.....
23 *	Sheet	50% Reduction	38000	35000	4.0	55	....	....	....	.....	.....
23 *	Sheet	Annealed, 300° C.	26500	16900	12.5	...	....	....	....	.....	.....
23 *	Sheet	Quenched, 620° C.	30200	18600	12.5	...	....	....	....	.....	.....
23 *	Sheet	Quenched, 620° C., Aged	33400	24300	12.0	54	....	....	....	.....	.....
25 *	Sheet	75% Reduction	53100	50750	2.8	81	....	14.55	....	.....	.....
25 *	Sheet	Annealed, 750° F.	39170	22450	14.3	65	13.85	....	....	.....	.....
25 *	Sheet	Quenched, 1115° F.	38780	20250	18.7	65	16.95	....	....	.....	.....
25 *	Sheet	Annealed, 1115° F.	33500	16250	18.3	59	....	....	....	.....	.....
32.51	Sheet	50% Reduction	52900	47900	2.0	...	....	....	....	.....	.....
39 *	Sheet	75% Reduction	58360	56150	0.5	...	19.5	....	....	.....	.....
39 *	Sheet	Annealed, 650° F.	37920	33300	1.7	...	....	....	....	.....	.....
39 *	Sheet	Annealed, 775° F.	39470	32900	2.0	...	....	....	....	.....	.....
39 *	Sheet	75% Reduction	62890	58450	1.5	94	18.3	....	....	.....	.....
39 *	Sheet	Annealed, 750° F.	45860	33550	7.3	75	14.75	....	....	.....	.....
39 *	Sheet	Quenched, 1115° F.	44630	27750	9.7	78	15.9	....	....	.....	.....
39 *	Sheet	Annealed, 1115° F.	41460	23150	14.5	68	....	..	....	.....	.....
40 *	Sheet, 0.008 in.	As rolled	40000	31000	1.5	...	22.0	....	....	.....	.....
40 *	Sheet, 0.156 in.	Annealed	22000	13500	5.0	...	....	....	....	.....	.....
67.5	Cast	Sand cast	13700	13600	0.0	75	20.4	....	....	.....	.....
67.5	Cast	Tested, 500° F.	10480	.....	1.0	57	(Room Temp.)	....	....	.....	.....
70 [2]	Cast	Chill cast	25000	19000	3.0	86	29.0	....	....	.....	.....

(Sheet Samples .064 in. thick unless noted.)

Aluminum Beryllium Alloys with Added Component

25 ±	Rolled	Annealed	60700	36500	12.0	...	17.5 [3]	....	....	.....	.....
25 ±	Rolled	25% Reduction	72710	64900	3.5	...	13.7 [3]	....	..	.....	.....
25 ±	Rolled	50% Reduction	82500	72700	3.5	...	14.8 [3]	....	....	.....	.....
25 ±	Rolled	75% Reduction	88900	82200	0.5	...	14.6 [3]	....	....	.....	.....
25 ±	Rolled	75%; tested at 600° F.	18100	7800	34.0	...	7.15 [3]	....	....	.....	.....
25 ±	Extruded	Quenched and aged [4]	54500	40800	7.0	116	16.7 [3]	....	36.1	30000	0.9857 [5]
25 ±	Extruded	Q&A [4]; tested at 400° F.	3500	.....	0.0	...	....	....	....	20000	0.4578 [5]

* Nominal (intended) composition.
[1] Contains 0.36% Mg as impurity.
[2] Endurance (20 × 10^7 cycles) 11000 psi.
[3] Close approximations.
[4] Quenched after 6 hrs. at 950 deg. F.; aged 16 hrs. at 310 deg. F.
[5] Failed.

Production of "Silvery Pig Iron"

A PICTORIAL PRESENTATION

A unique feature in the production of "silvery pig iron" in the blast furnace is that coal is used in addition to coke. Silvery iron is high in silicon (5 to 17%) and in order to get this into solution in the iron, higher furnace temperatures and a richer reducing atmosphere are necessary. Coal is used to help provide these conditions and also as an aid in holding the smelting zone down and keeping the furnace top cool. In addition to the coal, other raw materials used are iron ores, coke and limestone.

Silvery pig iron was first made in America, its commercial use in foundries and steel plants developed in this country and the United States has always led the world in its production. The Jackson Iron and Steel Company, Jackson, Ohio, is one of the largest producers of this grade of iron.

This presentation tells with pictures some of the various steps in the production of this high silicon iron at Jisco Furnace. We are indebted to Bradley H. Booth, metallurgist of the company, for the illustrations and the data for the text. The photographs are the work of Ralph Ernst of Columbus, Ohio. —E. F. C.

The plant of the Jackson Iron and Steel Company, Jackson, Ohio, where silvery iron is made in the blast furnace using coke and Sharon No. 1 coal as fuel.

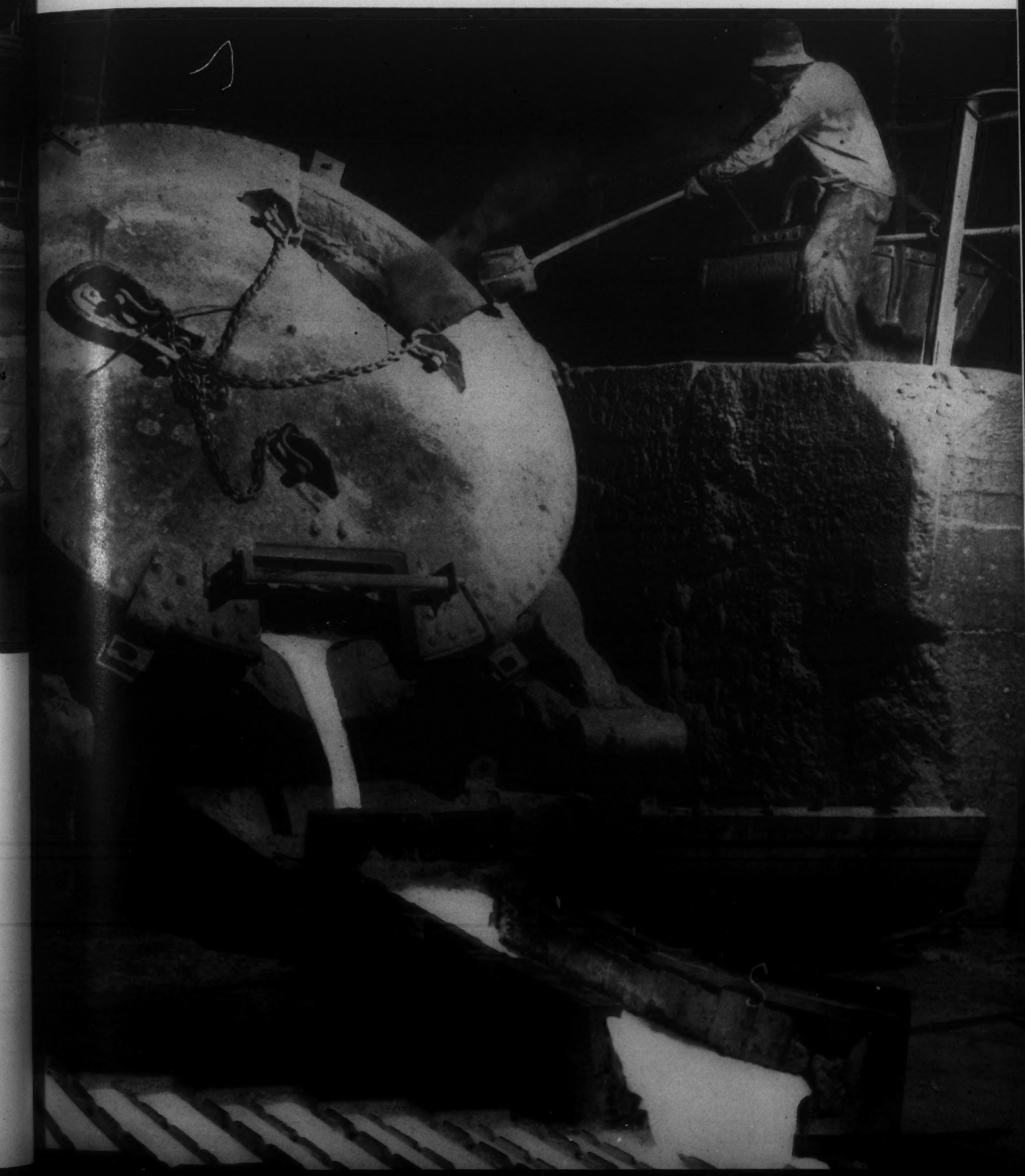
A load of coal from the mine destined for consumption in the furnace. The hot blast stoves appear in the background. The high silicon content of the iron is made possible through the use of silicious iron ores in conjunction with the coal, regular ores, coke and limestone.

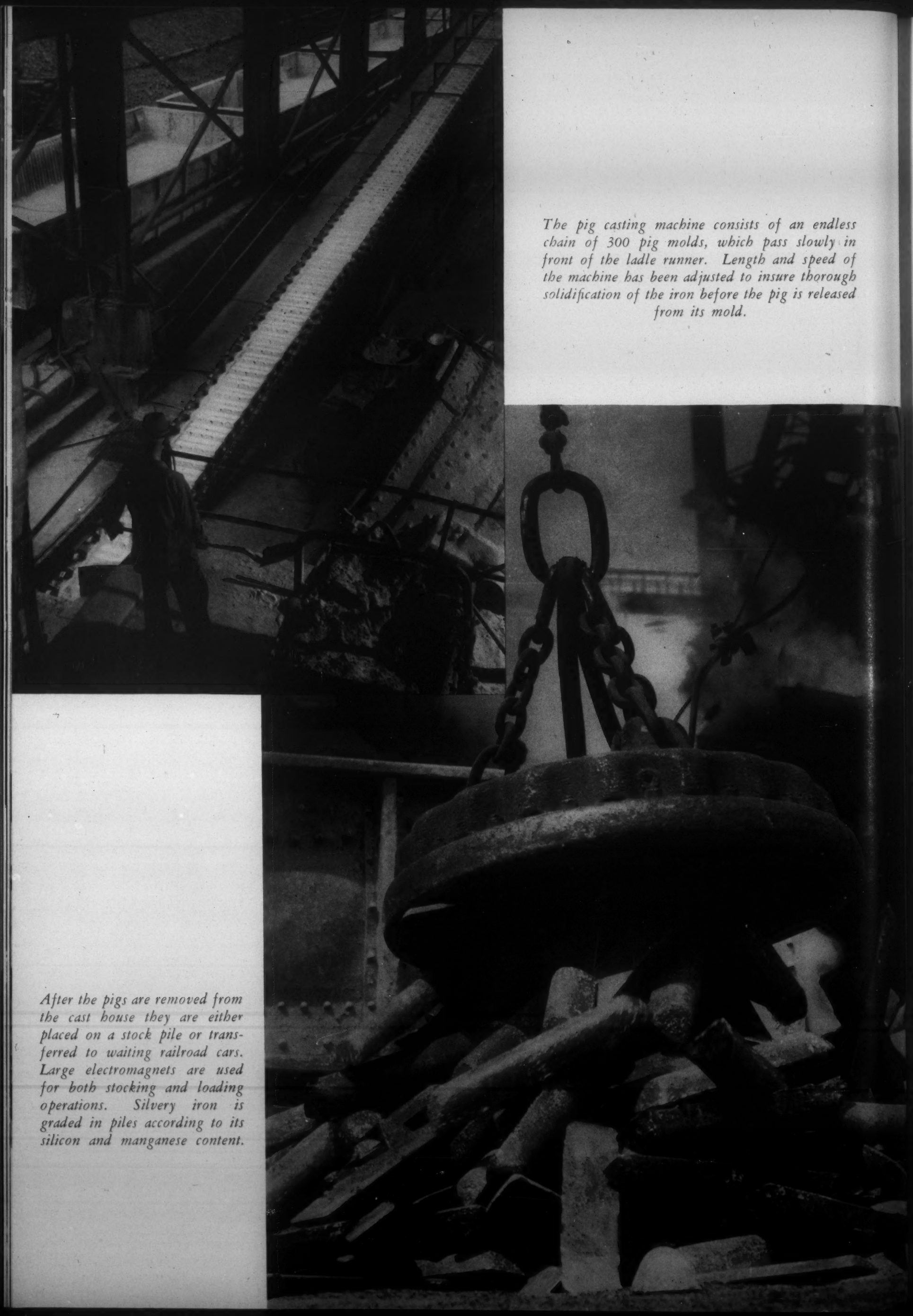
Because of the close specifications to which silvery pig iron is sold, everything going into the burden is carefully weighed on this specially constructed scale car. It runs on a track beneath the stock bins, which contain the various raw materials used in the smelting operation. When loaded, the car travels to a point over the hoist and discharges its load into the skip car.

The skip car is then drawn up the skip hoist track and dumped. A McKee Top distributes the materials uniformly as the charge passes on to the big bell, which receives several loads before discharging into the furnace.

The men in the picture are "rodding" the tap hole, an operation made necessary by the tendency of the iron and slag to chill towards the end of the cast. It takes about twelve hours for a charge to pass through the furnace, and be thoroughly reduced from oxides to elements. Every four to six hours a cast of silvery pig iron is tapped.

The cast is received in a covered ladle. This ladle is then tipped forward by an overhead crane, allowing the molten iron to flow down the runner into passing pig molds. Dolomite is thrown on the melt as a protective layer, which helps keep the iron hot. Casting temperature of silvery iron is about 2750 deg. F.

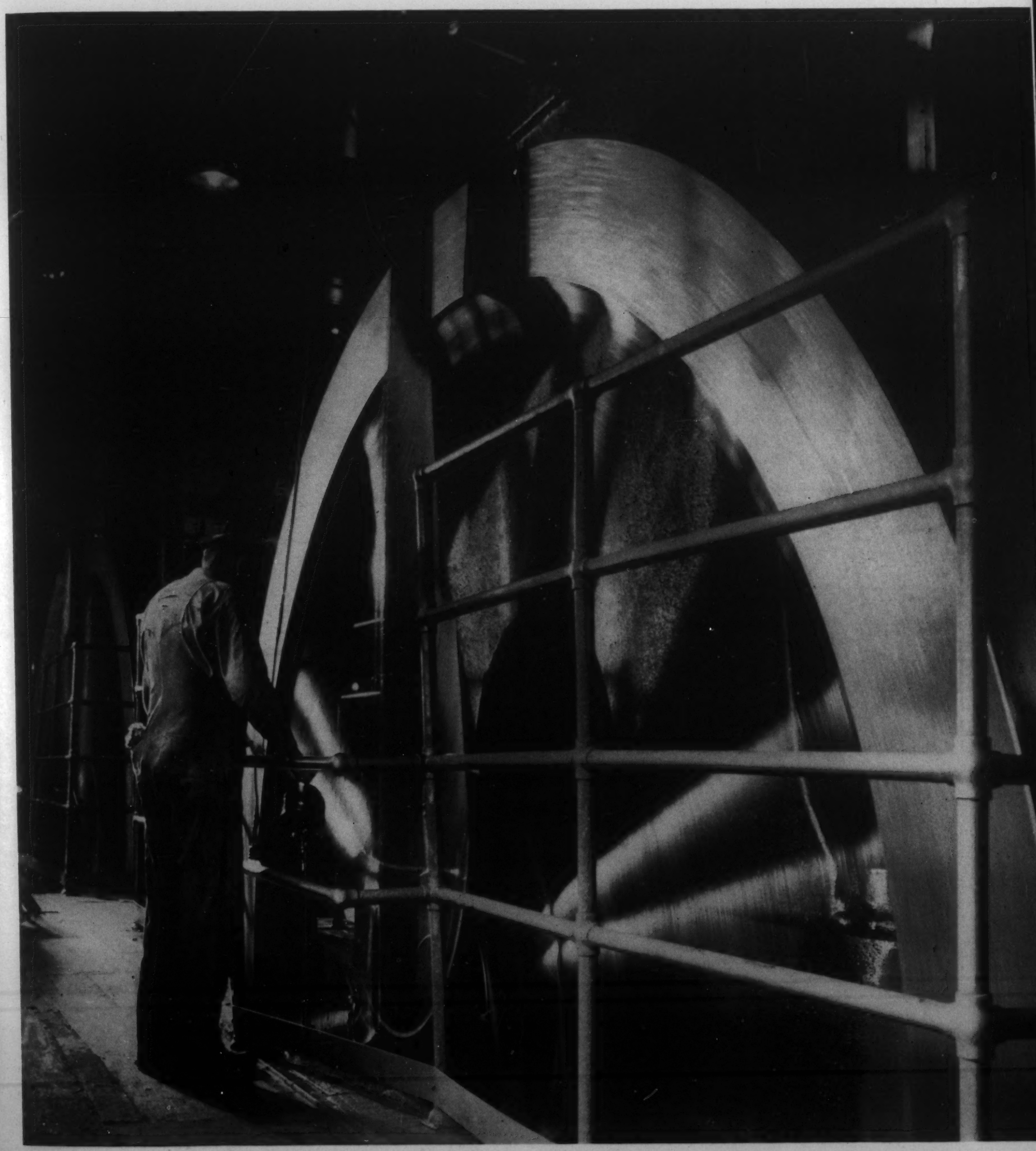




The pig casting machine consists of an endless chain of 300 pig molds, which pass slowly in front of the ladle runner. Length and speed of the machine has been adjusted to insure thorough solidification of the iron before the pig is released from its mold.

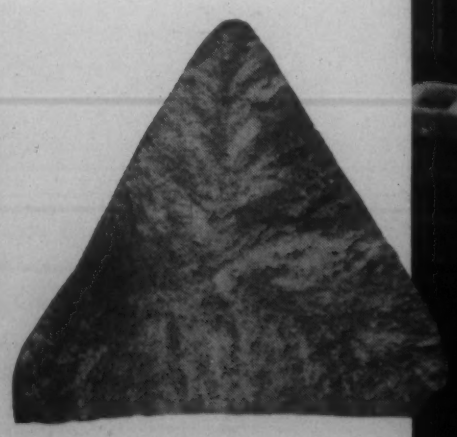
After the pigs are removed from the cast house they are either placed on a stock pile or transferred to waiting railroad cars. Large electromagnets are used for both stocking and loading operations. Silvery iron is graded in piles according to its silicon and manganese content.

Three blowing engines, of special design, supply several thousand cubic feet of air per minute to the hot blast stoves. Two operate all the time, with one as a spare. A blast pressure of 10 to 12 pounds is used in making the 10 per cent grade of silvery iron.



Furnace slag is sent to a processing plant, where it is crushed into various sizes for use in highway construction and making concrete. In the production of silvery iron slag control is an important factor. When making the 10 per cent grade about 1500 pounds of slag are produced to every ton of iron. This high slag volume acts as a filter to remove impurities from the iron as it trickles through.

There are many varieties of pig iron, including: basic, bessemer, foundry, silvery, etc. This picture represents a pile of silvery pig iron, while the cut at the side depicts its silvery appearing fracture. Similar in shape to other pig irons, it is higher in silicon (5-17%) and lower in carbon (0.80-3.00%). It is used in iron foundries and steel plants as a source of silicon, a deoxidizer, a fuel, to block heats and for control of ferric oxides in slag.



Electrolytic Manganese

ALLOYED WITH COPPER AND NICKEL-II

Concluded from June

by B. L. AVERBACH

Department of Metallurgy, Rensselaer Polytechnic Institute, Troy, N. Y.

X-Ray Investigations

A diffraction picture of Alloy No. 47 (49% Mn, 49% Ni, 2% Cu) after it had been quenched from 950 deg. C. showed a face centered cubic structure with a lattice parameter of 3.651 A (Figs. A and B). This alloy was ductile and had a resistivity of 204 microhm-centimeters. Upon aging at 500 deg. C., this alloy became extremely brittle and the resistivity dropped to 152 microhm-centimeters. By the graphical method of Hull and Davey,[11, 12, 13, 14] it was determined that the face-centered cubic lattice had altered to a face-centered tetragonal having the following dimensions:

$$a = 3.737 \text{ A}$$
$$c = 3.513 \text{ A}$$
$$C = \frac{c}{a} = 0.94$$

These agree closely with the values of Valentiner and Becker[10] for an alloy of 50 per cent Mn and 50 per cent Ni, and with those of Kaya and Kussman[15] for an alloy of 48 per cent Mn and 52 per cent Ni.

The presence of definite superstructure lines indicated that, in addition to changing to the tetragonal lattice, the atoms had so arranged themselves that the structure could now be represented by two intersecting base-centered tetragonal lattices of manganese and nickel atoms. If the crystal axes are rotated 45 deg., this structure further simplifies into two interlocking simple tetragonal lattices of nickel and manganese. This ordering of the lattice would account for the drop in resistivity, and could account for the brittleness because of the presence of separate planes of nickel and manganese.

Metallographic examination showed that, in addition to the change in structure, aging had brought about the precipitation of a new phase at the grain boundaries (Fig. C). Such a precipitate could in itself cause the brittleness and would also tend to lower the resistivity. Etching rates for the ordered and disordered conditions were remarkably different. Whereas the aged alloy could be etched in a 1:1 solution of 10 per cent NaCN and 10 per cent $(NH_4)_2S_2O_8$ in 2½ min., it took 3 hrs. to etch satisfactorily a quenched sample in the same solution. Such a difference in the rate of chemical attack may be explained by the precipitation of the second phase and by the ordering of the lattice.

In the Mn-Cu system, aging at 500 deg. C. produced a drop in resistivity, for alloys with less than 90 per cent Mn, without an accompanying embrittlement. Dean[7] accounted for such a phenomenon by the assumption of superlattices at Mn_9Cu and Mn_2Cu. A glance at Fig. 5 and at Dean's own data does not show the sharp dips in resistivity which occur at definite compositions in a system, such as the Au-Cu system, where superlattices are formed.

X-ray examination of Alloy No. 8 (67% Mn, 33% Cu) showed that before, as well as after aging at 500 deg. C., the structure was face-centered cubic, with no evidence of superlattice lines in either case. After aging, however, the lattice shrank from 3.743 A to 3.719 A or 0.64 per cent, while the resistivity decreased from 184 to 126 microhm-centimeters or 37.5 per cent. Metallographic examination of the aged alloy showed no evidence of precipitation. For this alloy, therefore, the decrease in resistivity upon aging cannot be attributed to the formation of an ordered lattice or to the precipitation of another phase, but it may be attributed to the contraction of the lattice.

Fig. A—X-Ray Data

Alloy No. 47 (49% Mn, 49% Ni, 2% Cu)
FeK radiation
R = 2.885 cm.
$K\alpha_1 = 1.9321$, $K\alpha_2 = 1.9360$ } 1.9341
$K\beta = 1.7530$

Quenched from 950 deg. C. — *Face-centered cubic*

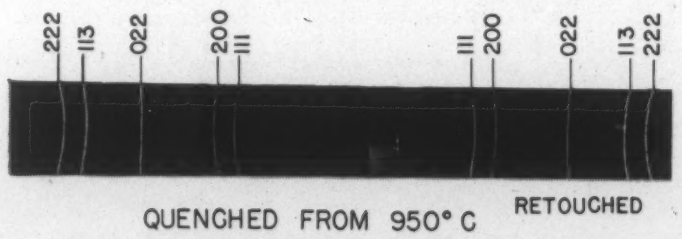
l (cm.)	θ	*hkl*	*a (A)*
3.745	27° 16′	111	3.657
3.215	31° 55′	200	3.658
4.845	48° 7′	022	3.674
6.120	60° 46′	113	3.675
6.610	65° 38′	222	3.678
			average 3.688

Aged at 5000 deg. C. for 10 minutes:

l (cm.)	θ	*d (A)*	*hkl*			*a (A)*
2.195	21° 48′	2.604		face-centered tetragonal		3.720
2.480	24° 37′	2.322	111 (β)		110	
2.750	27° 19′	2.107	111		superlattice lines	3.729
3.155	31° 20′	1.860	200			3.719
3.333	33° 6′	1.771	002			3.763
3.441	34° 10′	1.722			210	
4.745	47° 7′	1.320	220			3.733
4.975	49° 24′	1.274	202			3.719
6.000	59° 35′	1.121	131			3.743
6.230	61° 52′	1.097			103	
6.460	64° 9′	1.075	113			3.751
6.660	66° 9′	1.057	222			3.742
						average 3.737

$C = \frac{c}{a} = 0.94$ a = 3.737 A c = 3.513 A

Fig. A. X-ray data Alloy No. 47 (49% Mn, 49% Ni, 2% Cu).



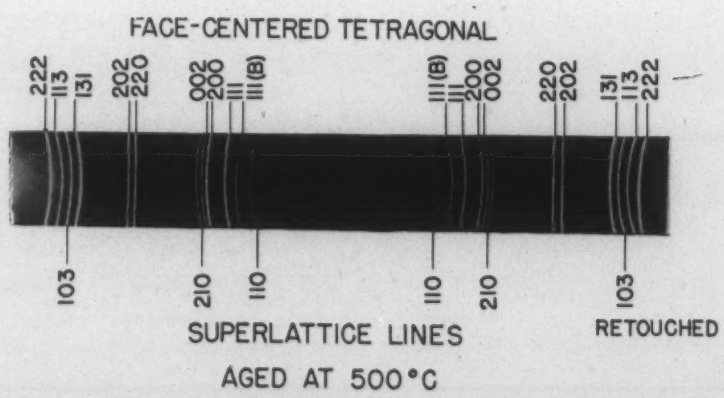


Fig. B. Debye-Scherrer X-ray diffraction pictures. Alloy No. 47 (49% Mn, 49% Ni, 2% Cu).

Correction

Due to a typographical error, Table 3 in Part I (June issue) should be Table 5.

Temperature Coefficients of Electrical Resistance

From Fig. 8 it is evident that most of the ternary alloys at 67 per cent Mn had low temperature coefficients of resistance, the order of magnitude being $+0.5 \times 10^{-4}$ per deg. C., with the coefficients usually positive when copper was in excess of nickel. Alloy No. 51 (60% Mn, 39% Ni, 1% Cu) had a coefficient of zero up to 75 deg. C. (Fig. 8) while at the 50:50 ratio of Mn:Ni and at the 2:1 ratio of Mn:Cu (Fig. 9) the coefficients were of the order of $+0.9$ to -1.7×10^{-4} per deg. C. For Alloy No. 7 (63.4% Mn, 5% Ni, 31.6% Cu) the lowest negative coefficient obtained in this investigation was recorded at -8.4×10^{-4} per deg. C.

The 75 per cent Mn alloys (Fig. 10) showed considerable variation in coefficients, while at 80 per cent Mn the alloys had low coefficients except where the copper was high in relation to the nickel. Both the Mn-Cu and the Mn-Ni binary systems exhibited high coefficients (Fig. 11) and at 95 per cent Mn, 5 per cent Cu (Alloy No. 22) the highest positive coefficient was noted at 20×10^{-4} per deg. C.

Thermoelectric Force vs. Copper

None of the alloys in this investigation developed a high thermoelectric force against copper. In general, for the ternary alloys, the greater the copper content, the more negative was the thermoelectric force. Alloys No. 45 (67% Mn, 28% Ni, 5% Cu) and No. 28 (67% Mn, 22% Ni, 11% Cu) had particularly low values of thermal e.m.f., developing —0.15 microvolts per deg. C. (Table 4). Fig. 14 shows that Alloy No. 36 developed practically no e.m.f. up to 75 deg. C.

Neither the 50:50 Mn:Ni nor the 2:1 Mn-Cu series produced alloys of particularly low thermal e.m.f., while the 75 to 90 per cent alloys showed thermoelectric forces which were generally negative. Both the Mn-Cu and the Mn-Ni binary alloys developed negative thermoelectric forces, and while in the Cu-Mn system the e.m.f. became less negative as the copper content increased, neither system developed as low a thermoelectric force as the corresponding ternary alloys.

Silver Alloys

In an effort to see whether silver was more effective than copper in stabilizing the ductile modification of manganese, up to 5 per cent of Ag was added to the 50:50 Mn:Ni series. The resistances were high as cast, but unfortunately no heat treatment made the alloys ductile (Table 2).

At 67 per cent Mn (Alloy No. 58—67% Mn, 32% Ni, 1% Ag) the silver did produce a duc-

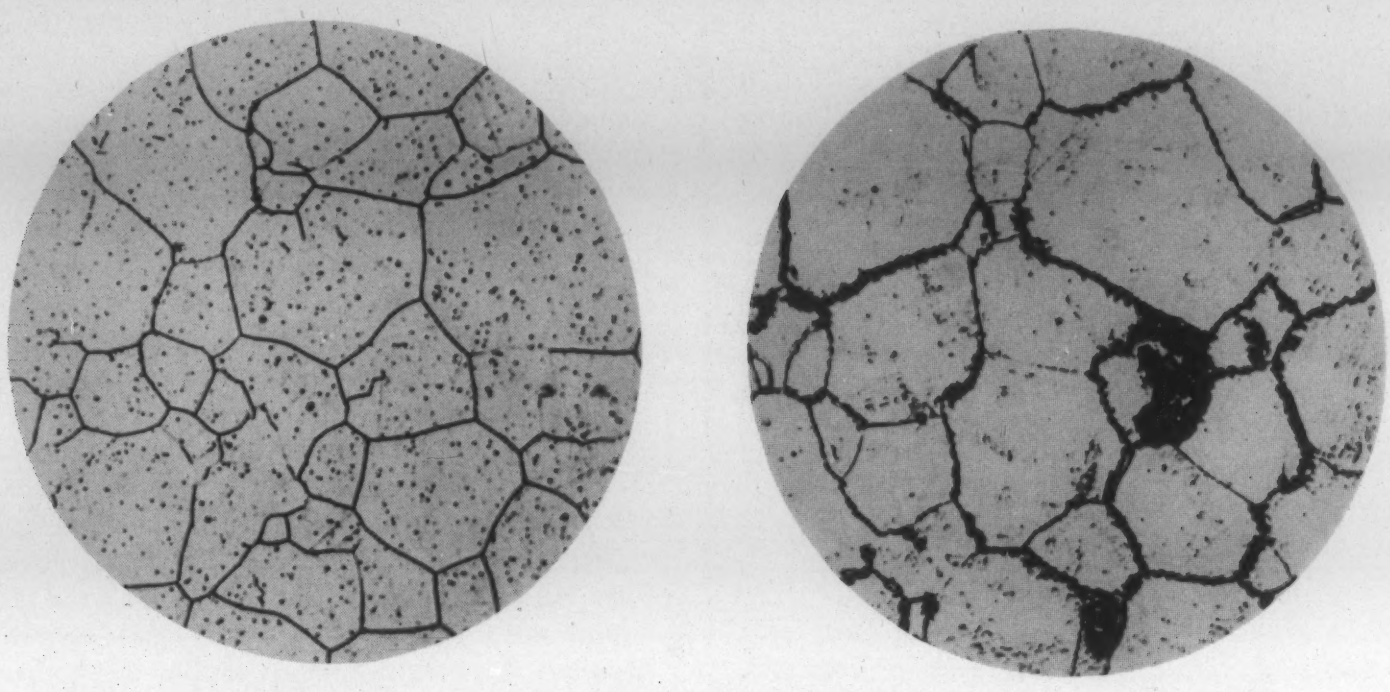


Fig. C Alloy No. 47 (49% Mn, 49% Ni, 2% Cu.) (Left) Quenched from 950 deg. C. (Right) Aged at 500 deg. C. 300 X.

Table 3.—Effect of Aging at 500 Degrees C. on Resistivity

R = Resistivity in Microhm—cm

	Composition			Quenched		Aged at 500 deg. C.			
						5 min.		30 min.	
No.	Mn	Ni	Cu	R	Workability	R	Workability	R	Workability
1	47.5	47.5	5.0	201	good	...	brittle	...	....
2	42.5	42.5	15.0	181	good	...	brittle	...	...
3	37.5	37.5	25.0	144	good	...	brittle	...	...
47	49.0	49.0	2.0	204	good	...	brittle	...	....
5	45.0	45.0	10.0	173	good	...	brittle	...	....
6	40.0	40.0	20.0	148	good	...	brittle	...	....
7	63.4	5.0	31.6	190	good	190	good	187	good
9	60.0	10.0	30.0	196	good	180	good	179	good
10	56.7	15.0	28.3	193	good	190	good	186	good
11	53.4	20.0	26.6	178	good	188	good	184	good
11a	53.4	20.0	26.6	170	good	173	good	172	good
12	46.7	30.0	23.3	169	good	172	good	165	good
15	40.0	60.0	...	126	good	139	brittle	...	....
17	80.0	20.0	...	218	good	200	fair	...	....
18	85.0	15.0	...	196	good	165	good	165	good
20	95.0	5.0	...	128	good	142	good	...	....
62	96.0	...	4.0	80	good	...	....	250	brittle
22	95.0	...	5.0	115	good	121	good	129	fair
23	90.0	...	10.0	136	good	130	good	130	fair
24	85.0	..	15.0	150	good	130	good	128	good
25	80.0	...	20.0	176	good	134	good	133	good
26	75.0	...	25.0	189	good	139	good	128	good
8	67.0	...	33.0	184	good	138	good	126	good
27	60.0	...	40.0	186	good	139	good	132	good
31	40.0	50.0	10.0	194	good	...	brittle	...	....
32	50.0	40.0	10.0	197	good	...	brittle	...	....
33	50.0	25.0	25.0	186	good	190	good	188	good
34	50.0	20.0	30.0	172	good	179	good	182	good
53	45.0	50.0	5.0	205	good	...	good	...	....
35	60.0	20.0	30.0	179	good	198	good	176	good
36	60.0	30.0	10.0	205	good	192	good	194	good
37	60.0	10.0	30.0	193	good	190	good	191	good
51	60.0	39.0	1.0	209	good	219	poor	...	....
28	67.0	22.0	11.0	208	good	201	good	201	good
29	67.0	16.5	16.5	203	good	201	good	201	good
30	67.0	11.0	22.0	197	good	190	good	190	good
45	67.0	28 0	5.0	220	good	225	good	226	good
46	67.0	5.0	28.0	200	good	188	good	186	good
50	67.0	32 0	1.0	218	good	223	fair		....
38	75.0	17.5	17.5	196	good	191	good	194	good
39	75.0	19.0	6.0	209	good	197	good	198	good
40	75.0	6.0	19.0	187	good	184	good	184	good
52	75.0	24.0	1.0	219	good	214	good	206	poor
41	80.0	10.0	10.0	215	good	187	good	189	good
42	80.0	18.0	2.0	184	good	188	good	191	good
43	80.0	2.0	18.0	185	good	172	good	171	good
44	90.0	5.0	5.0	171	good	152	good	155	good
61	97.0	1.0	2.0	112	good	...	....	163	brittle

tile alloy, and Fig. 7 shows that this alloy had a zero temperature coefficient up to 75 deg. C. In these alloys, silver and copper were roughly equivalent, but the silver-bearing alloys tended to form porous castings.

Summary

X-ray and metallographic investigations upon an alloy with a 50:50 Mn:Ni ratio showed that the drop in resistivity and the attendant brittleness was caused by two distinct mechanisms:

1. A change from the face-centered cubic lattice to an ordered condition represented by two interlocking simple tetragonals of Mn and Ni atoms.
2. Precipitation of a second phase.

In the Mn-Cu system there was no evidence of a superlattice at Mn_2Cu, and the drop in resistivity upon aging was caused by the contraction of the face-centered cubic lattice.

Table 5 lists a series of alloys selected for a combination of high resistivity, low thermoelectric force against copper, low temperature coefficient of resistance, and for a high degree of ductility. In the cases where the temperature coefficient was not strictly linear, the listed value represents an average value.

Of particular note are Alloys No. 45 (67% Mn, 28% Ni, 5% Cu) and No. 51 (60% Mn, 39% Ni, 1% Cu) which have a resistivity of 220 microhm-centimeters, more than four times the resistivity of manganin, along with a temperature coefficient of resistance and a thermoelectric force against copper which compare favorably with that of manganin.

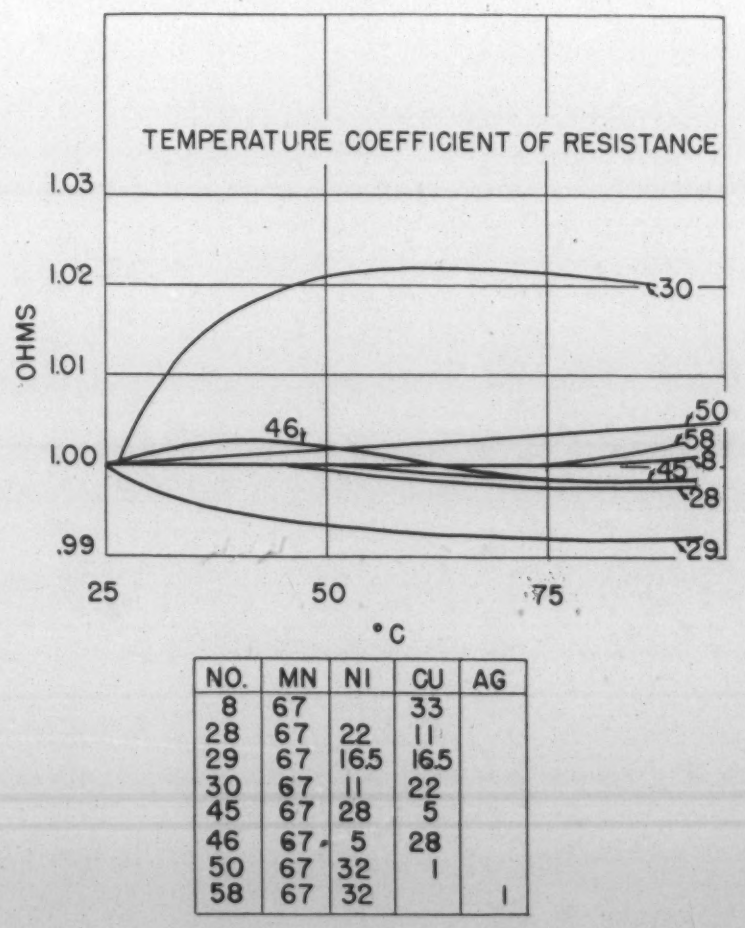
The author wishes to thank Dr. M. A. Hunter, Scott Mackay, A. Jones, Dr. H. M. Sullivan, E. F. Nippes and F. J. Haley, all of Rensselaer Polytechnic Institute, for their assistance during the course of this investigation.

Table 4.—Thermoelectric Force Vs. Copper Cold Junction 0 Deg. C.

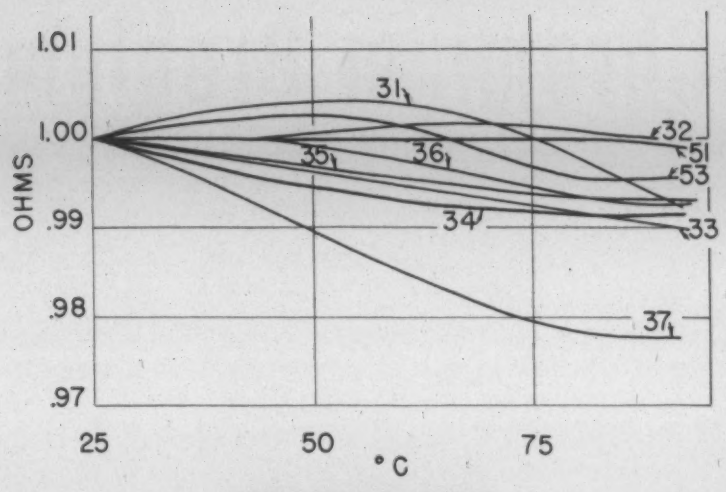
Alloy No.	Composition Mn	Ni	Cu	emf (0-100° C.) microvolts per deg. C.
15	40	60	...	—4.93
17	80	20	...	—1.85
18	85	15	...	—2.57
22	95	..	5	—3.74
23	90	..	10	—3.05
24	85	..	15	—2.00
25	80	..	20	—1.85
26	75	..	25	—1.11
27	60	..	40	—1.65
44	90	5	5	—3.05
43	80	2	18	—1.70
42	80	18	2	—1.90
40	75	6	19	—0.95
39	75	19	6	—0.45
38	75	17.5	17.5	—0.25
52	75	24	1	+0.46
8	67	..	33	—0.88
28	67	22	11	—0.15
29	67	16.5	16.5	—0.45
30	67	11	22	—0.65
45	67	28	5	—0.12*
46	67	5	28	—1.10
37	60	10	30	—0.83
36	60	30	10	0.00*
35	60	20	20	—0.37
34	50	20	30	—0.30
33	50	25	25	—0.10
32	50	40	10	+1.40
31	40	50	10	+0.73
7	63.4	5	31.6	—0.76
9	60	10	30	—1.02
10	56.7	15	28.3	—0.60
11	53.4	20	26.6	—0.45
6	40	40	20	+1.70
5	45	45	10	+2.10
3	37.5	37.5	25	+2.50
2	42.5	42.5	15	+2.22

* 0-75 deg. C.

Fig. 7. Temperature coefficient of resistance.

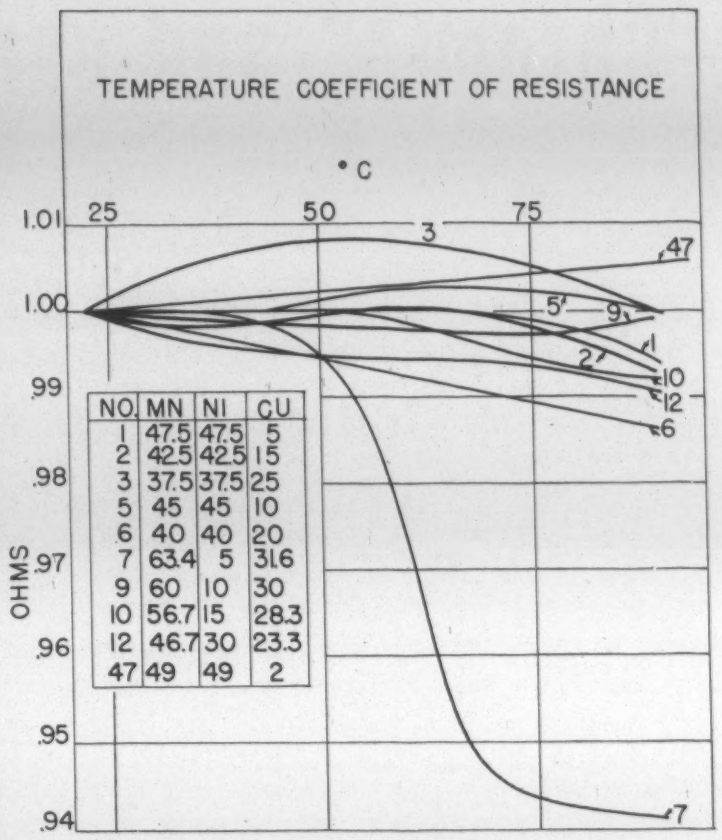


NO.	MN	NI	CU	AG
8	67		33	
28	67	22	11	
29	67	16.5	16.5	
30	67	11	22	
45	67	28	5	
46	67	5	28	
50	67	32	1	
58	67	32		1



NO	MN	NI	CU
31	40	50	10
32	50	40	10
33	50	25	25
34	50	20	30
35	60	20	20
36	60	30	10
37	60	10	30
51	60	39	1
53	45	50	5

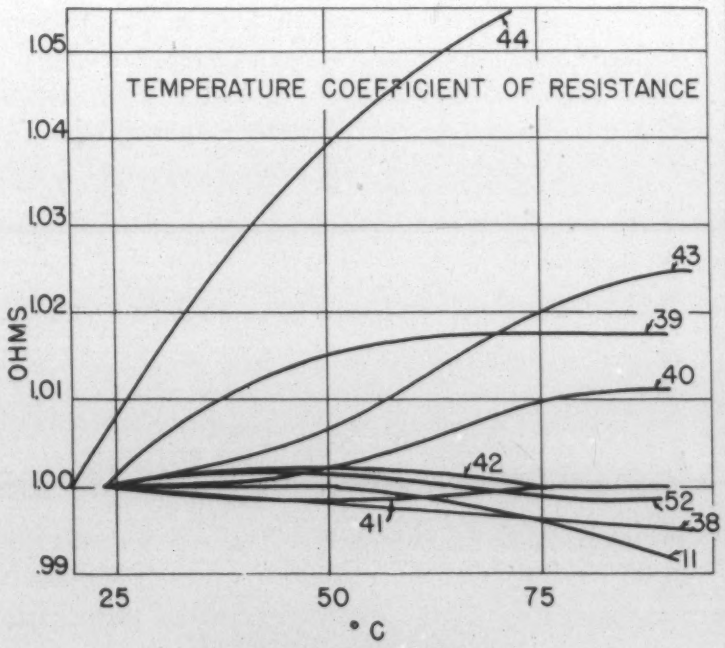
Fig. 8. Temperature coefficient of resistance.



NO.	MN	NI	CU
1	47.5	47.5	5
2	42.5	42.5	15
3	37.5	37.5	25
5	45	45	10
6	40	40	20
7	63.4	5	31.6
9	60	10	30
10	56.7	15	28.3
12	46.7	30	23.3
47	49	49	2

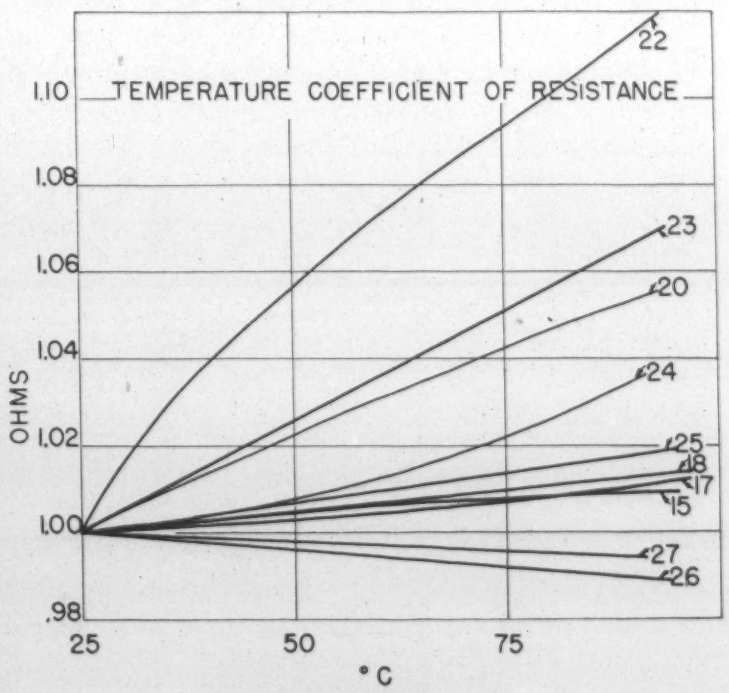
Fig. 9. Temperature coefficient of resistance.

Fig. 10. Temperature coefficient of resistance.



NO	MN	NI	CU
11	53.4	20	26.6
38	75	17.5	17.5
39	75	19	6
40	75	6	19
41	80	10	10
42	80	18	2
43	80	2	18
44	90	5	5
52	75	24	1

Fig. 11. Temperature coefficient of resistance.



NO.	MN	NI	CU
15	40	60	
17	80	20	
18	85	15	
20	95	5	
22	95		5
23	90		10
24	85		15
25	80		20
26	75		25
27	60		40

"Chrom-X" and our Chromium Problem

by MARVIN J. UDY
Vice-president in charge of research, Chromium Mining & Smelting Corp., Sault Ste Marie, Ontario, Canada.

At the annual conference of open-hearth operators in April in Chicago, the use of Chrom-X for introducing chromium into alloy steels was quite fully discussed and in the main the testimony was favorable. Application to both basic and acid practice was discussed.

We present here a description of the manufacture and use of the two grades of Chrom-X, high and low carbon. The importance of this development lies in the fact that this reagent for introducing chromium into steels can be made from low-grade domestic ores, relieving the reliance on high-grade ores, especially in an emergency such as the present. —The Editors.

FOR THE PAST FIVE YEARS research and development has been carried on by the Chromium Mining & Smelting Corp. in an effort to utilize so called low grade chrome ores. Since the present war has caused the re-occurrence of the chromium problem of the last war and since this company has reached a point in this development where its products have been tried and accepted in the steel trade, we feel free at this time to make known at least a part of these results, especially as they concern the use of the low grade chrome ores of the United States and Canada in the present emergency.

Our Chromium Problem

Our chromium problem does not rise from the lack of domestic chrome ore supplies but rather from the grade of these supplies. Today a commercial ore must have a chromic oxide content of 45 per cent or more and a chromium to iron ratio of at least 3 to 1. This specification has been established by custom which has called for a ferrochromium containing 68 to 70 per cent Cr. To produce such a grade of ferrochromium by the present day methods of smelting and refining, the ratio anticipated above is required. This of course is due to losses in smelting and refining. It is probable that the 68 to 70 per cent Cr content was established because this was about the best that could be produced from the highest ratio ores obtainable. From the producer's point of view this grade showed probably the greatest economy in transportation and from the user's point of view it gave him the least cold material to add to his furnace for the percentage of chromium desired in his steel. Had it been possible to find ores of a higher chromium to iron ratio it is possible that a higher grade ferrochromium than 70 per cent would have been made. It is not at all certain however that from the users' point of view this would have been economical since it becomes more difficult to melt in the steel furnace, the higher percentage of chromium in the ferroalloy. In any case this is the custom, and production of ferrochromium containing 68 to 70 per cent Cr demands high ratio ores which are imported from Turkey, New Caledonia, Rhodesia, Greece, India and other countries.

United States and Canada have chrome ore deposits, but for the most part the ratio of chromium to iron is low and the standard grade of ferrochromium cannot be made from them. From our study of the ore problem it seems that in general the low chromium to iron ratio ores are much more plentiful throughout the world than those of high ratio. Any process capable of handling the low ratio ores economically becomes of considerable importance in the present emergency.

"Chrom-X"—A Solution to the Problem

Any solution to the problem of using domestic low ratio ores must be one that will produce at least

a 68 to 70 per cent ferrochromium or new products which are at least equivalent in cost and in performance to the standard ferrochromium. In our development we have fortunately been able to meet these requirements and have solved the problem in such a manner that we are able to produce concentrates of high ratio suitable for production of standard ferrochromium or Chrom-X.

To produce concentrates of high ratio for the manufacture of ferrochromium a beneficiation is required to remove some of the iron and increase the chromium to iron ratio. This change of chromium to iron ratio is accomplished by fusing the ore or concentrate with lime and reducing the iron with part of the chromium, or by fusion of the ore with lime to replace the iron and part of the alumina from the chromite and then concentrating by water to remove the altered chromite of high chromium to iron ratio.

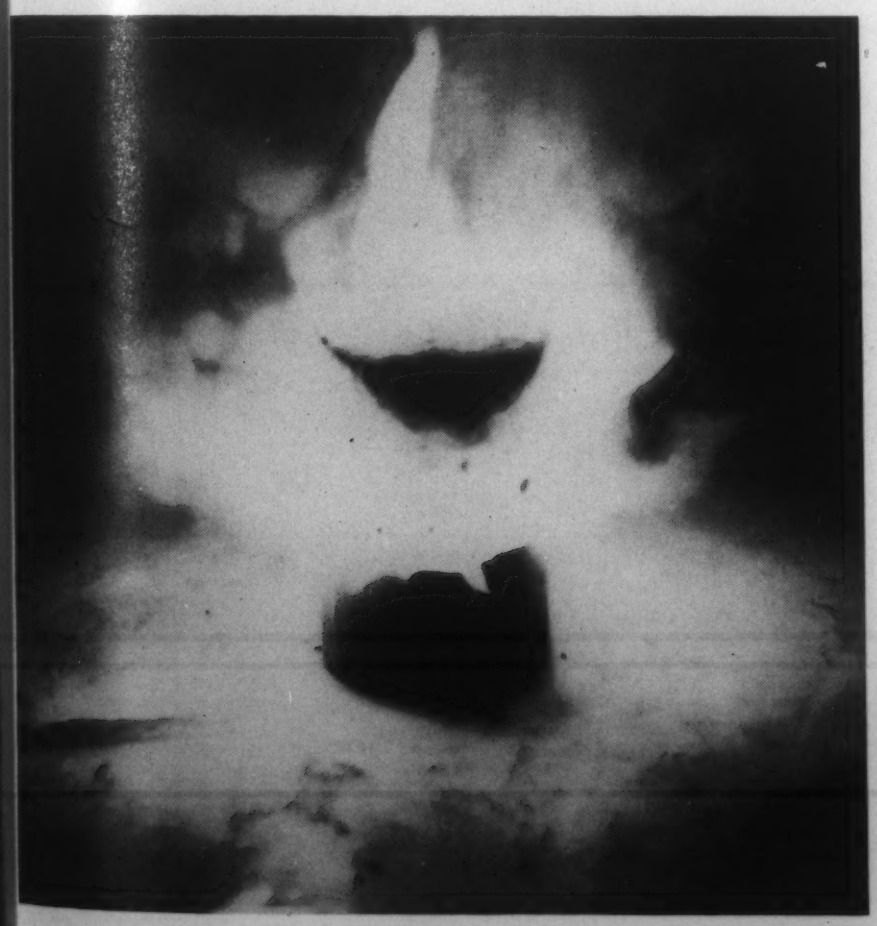
All chrome ores consist of a chromite and a silicate. The chromite is chiefly $FeO\text{-}Cr_2O_3$ with replacement of the FeO by MgO and the Cr_2O_3 by Al_2O_3. The silicate portion may vary considerably in composition. On the addition of lime it appears that MgO in the silicate is replaced, and in turn the MgO replaces FeO in the chromite. Increasing portions of lime then replace the FeO in the chromite and the Al_2O_3 and finally there is a complete decomposition of the chromite. If the quantity of lime is controlled so that complete decomposition is not reached, there results a constituent approaching magnesium chromite ($MgO{\cdot}Cr_2O_3$) which crystallizes as an altered chromite of higher specific gravity than the original chromite of the ore and can be readily concentrated from the silicate portion by water concentration. This concentrate may have a chromium to iron ratio of 8 to 1 or more, and after acid treatment as much as 50 to 1. To produce ferrochromium of 70 per cent grade this concentrate is simply used to sweeten a portion of the low ratio ore to a 3 to 1 ratio or better, and then smelted by standard methods. The economic success of this method of concentration requires cheap power and other favorable economic factors.

From the standpoint of ferrochromium of standard grade, this method of concentration gives satisfactory and economical results. From the standpoint of Chrom-X whether this concentration is necessary or desirable depends upon any given set of economic conditions. It is a method which can in some cases be used to advantage at the source of ore to save transportation charges and, carried out at such point, can produce high grade concentrates in competition with the high grade ores even in peace times.

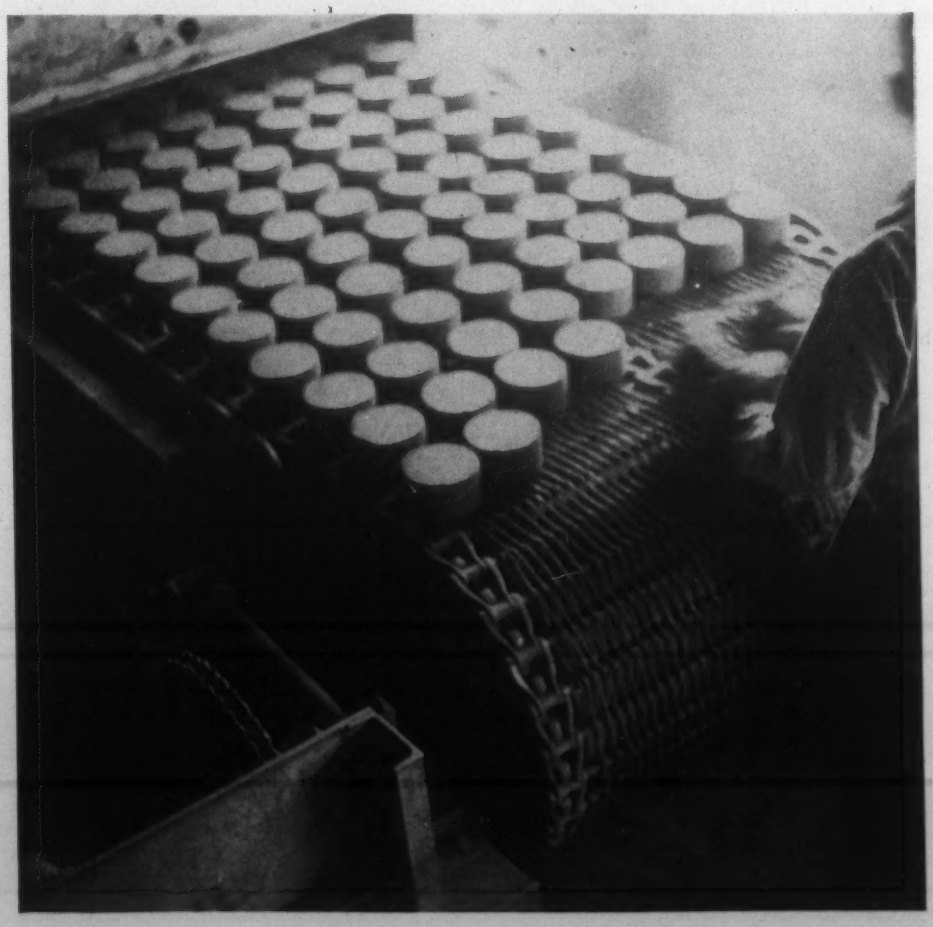
High Carbon Chrom-X

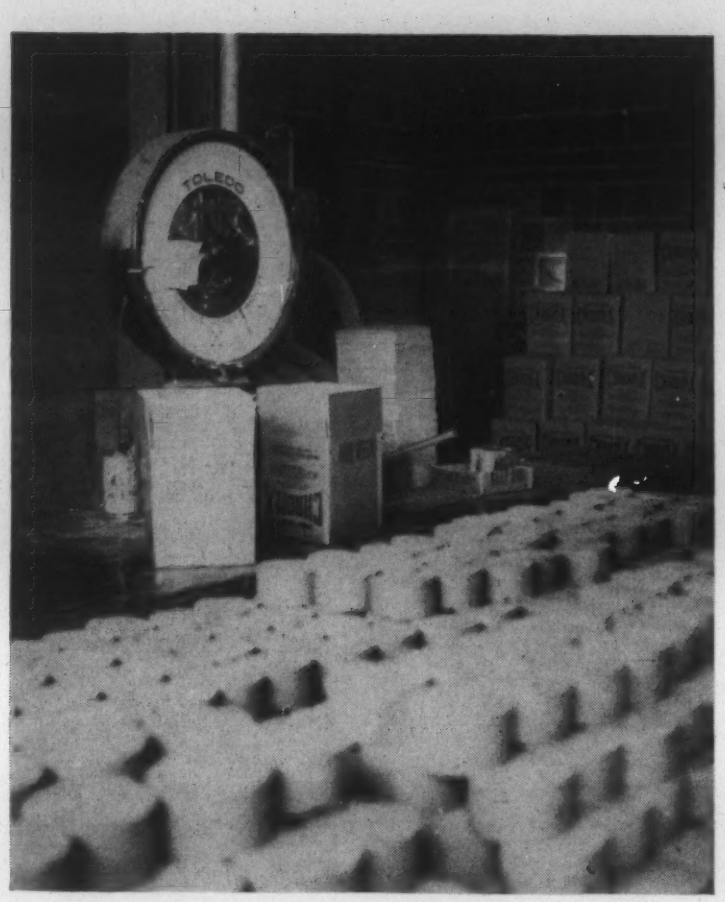
To produce Chrom-X a direct reduction of the ore or concentrate is made in an electric furnace with coke to produce a chromium-iron metal of 8 to 10 per cent C and up to 5 per cent Si. High carbon Chrom-X is made up of this metal mixed with sodium

High-carbon Chrom-X in ignition.



Chrom-X briquettes are heated to bond and form a solid brick.





Chrom-X is packed in cartons and weighed.

nitrate or other oxidizing agent such as sodium or calcium chromate in sufficient quantity to oxidize practically all of the silicon and part of the carbon. It is then briquetted and heated to bond it into a solid mass. The oxidizing agent forms the bond. Due to the fineness of the material and the thorough mixing, the product is uniform in composition.

When high carbon Chrom-X is added to the furnace there is an exothermic reaction which results in the production of a molten ferrochromium of about 6 per cent C, and a fluid slag of sodium silicate. Since Chrom-X delivers molten metal to the steel bath the objection to low grade ferrochromium namely, that of too much cold metal to be added to the steel is overcome and low grade or low ratio chrome ores are now successfully used.

Low Carbon Chrom-X

Low carbon Chrom-X is a compounded mixture of silicon or an alloy of silicon of very low carbon content (0.01 to 0.02%) and a mixture of the oxides of chromium and iron in chemical combination with lime. These oxides are made by oxidizing chromium-iron metal containing 8 to 10 per cent C with lime at a high temperature and so controlling the operation as to get about 50 per cent of the chromium as Cr_2O_3 and about 50 per cent as CrO_3. These ratios may be varied to produce the correct amount of heat such that, when the Chrom-X reacts on the steel bath, it neither chills nor overheats the steel. The oxides and the silicon are ground together to minus 100 mesh and bagged for shipment or moistened and briquetted and heated to bond and form a solid brick. The silicon is present in about 10 per cent excess over that required to reduce the oxides of iron and chromium. The carbon content is very low and will be of the order of 0.02 per cent or less.

The chief reason for using a mixture of chromite and chromate made from oxidation of metal made by the direct reduction of chrome ore is to lessen the slag volume produced from the Chrom-X when used in the steel furnace. The chromite-chromate mixture is also made directly from the ores, particularly ores of high chromium content. Methods have been developed to increase the grade of the low carbon Chrom-X; however, for those who can handle a somewhat higher slag volume the lower grade Chrom-X is of course the lowest cost chromium.

When Chrom-X is added to a steel bath it reacts smoothly and rapidly to produce molten low carbon ferrochromium.

Low-carbon Chrom-X is bagged and weighed.

Advantages of High and Low Carbon Chrom-X

High carbon Chrom-X has been used extensively in Canada, the United States and in England over the past year with excellent results. It has been used in small foundries where 50 to 100 lbs. of iron are treated and in 200-ton heats of steel in open-hearth furnaces. It has shown uniform results. Recoveries of 90 to 95 per cent as compared to 80 to 85 per cent with ferrochromium are obtained. It has decreased the time of heat and decreased the fuel consumption. Its uniformity has made it easier to obtain the desired chromium content in the steel. Some three to four million pounds of chromium as high carbon Chrom-X have been used in United States since January, 1941.

Low carbon Chrom-X has the same advantages as high carbon Chrom-X. In addition it has great potential possibilities in that it makes possible the production of high chromium steels in the open-hearth furnace. Steels which heretofore have been thought possible to make only in the electric furnace are made with relative ease in the open-hearth furnace using Chrom-X. Low carbon Chrom-X does not take heat from the furnace but actually supplies heat. As much as 12 per cent Cr has been added to 50 tons of steel in 45 min. in an open-hearth furnace. Improvements in progress will increase the total chromium content of the low carbon Chrom-X and with this increase in total chromium content there will follow further advantages to the steel maker.

Future of the Development

The company has reached a stage in its development far beyond the experimental. It has a plant in operation at Sault Ste Marie, Ontario, with total capacity of 24,000 kw. and it contemplates the enlargement of this plant to meet the increased demands in Canada and England. The company further plans the building of a plant in the United States, to take care of the rapidly increasing demand, which has developed. Both plants will be able to operate on domestic or imported ores.

The principle applied in the manufacture of Chrom-X, namely that of using the heat of combustion of silicon and carbon to melt metals and other materials, is capable of application to iron, manganese, silicon, vanadium, tungsten, nickel, copper etc. It is the intention ultimately to produce all the alloys in form similar to Chrom-X. The whole scheme of metallurgy involved in the use of low grade chrome ores and the resulting products and their uses have been the subject of a broad group of patent applications throughout the world, a number of which have been already granted and others will issue shortly.

Summary

The results of five years of research and endeavor to develop methods of using low grade domestic ores or low grade imported ores have resulted in an economically commercial process for producing (1) Chrom-X, (2) a concentrate from which Chrom-X or standard ferrochromium can be made, and (3) a process which is being expanded to the use of iron, manganese, silicon, vanadium, tungsten, nickel, copper and the other alloying metals.

Chrom-X is made in two grades, namely, high and low carbon. These can be used in any proportion to give the desired carbon content. Chrom-X does not depend on the chrome-iron ratio of the ore. It produces a savings for the steel maker and increases production by decreasing the time of heat, by decreasing the fuel consumption, by increasing recoveries, and in the ease of handling. It further makes possible the manufacture of high chromium steels in larger tonnages in open-hearth furnaces.

Rotary kiln for oxidation to chromate-chromite for the low-carbon Chrom-X.

CONCLUDED FROM JUNE

Hydrogen in Steel and Cast Iron—IV

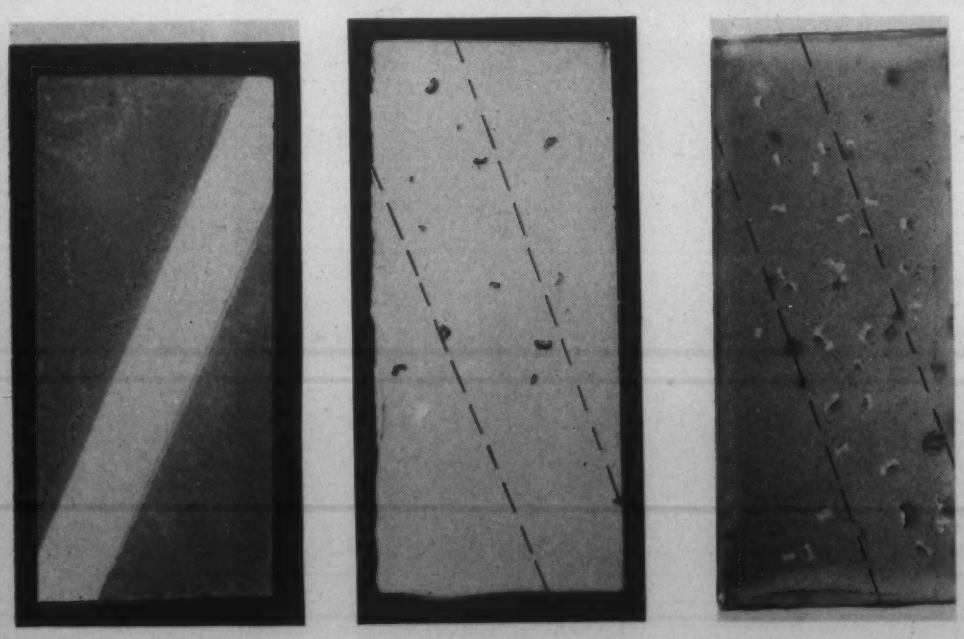
AND DEFECTS IN APPLIED COATINGS

by C. A. Zapffe and C. E. Sims

Research Engineer and Supervising Metallurgist, respectively, Battelle Memorial Institute, Columbus, Ohio

An interesting activity of carbon is again shown in Fig. 27. A 3/16-in. mild steel plate was copper-plated, machined diagonally as shown and carburized so that a 0.03-in. high-carbon case resulted along the diagonal. The piece was prepared by pickling but baked for a period sufficient to drive off most hydrogen except that held by the carbon or occluded molecularly. During firing, hydrogen was liberated from the carbon. The portion of the gas on the surface of the diagonal caused some boiling. Deeper-seated portions were largely liberated to the steel, but not rapidly enough to cause boiling on the opposite face. Two days after firing, fishscales began to appear on the opposite (low carbon) face—first, over areas corresponding quite well to the diagonal area behind, and, later, generally spreading over the face. Slip for a second coat was applied and, during baking at 115 deg. C. (240° F.), the increased rate of diffusion caused the hydrogen to effuse so rapidly that bits of slip were blown away, and usually from sites of underlying fishscales. The piece was fired regardless, and effusion continuing over an extended period caused the piece to appear as shown in Fig. 27.

Fig. 27. (Left) Carburized diagonal area on back of copper-plated steel plate. (Center) Baked unfired slip of second ground coat on front of plate. (Right) Second ground coat after firing.



The accelerating effect of heating on hydrogen effusion is shown again in Fig. 28. A compounded plate made of two discs cleaned, rim-welded, heated and rolled just as the specimen in Fig. 7 of the previous paper,[1] was fired with ground coat at 870 deg. C. (1600° F.). Hydrogen from the preparatory pickling treatment had presumably become trapped at the disjunctions between the two plates and was released from occlusion during firing. No boiling occurred, nor did any chipping appear until 10 days after firing. Then a fishscale did appear, and in six weeks about two dozen were present. The plate was heated to 200 deg. C. (390° F.) and in 5 min. the number of fishscales increased to over 100. Further heating effected no more scaling, nor have any developed since.

The preceding test is an excellent illustration of the "delayed fishscaling" that sometimes requires years for sufficient pressures of gas to accumulate. Fig. 29 shows the chronology of hydrogen effusion as identified by enameling defects. A steel bar ½ by ¾ by 5 in. was drilled longitudinally with a centered ¼-in. hole, filled with glass rod to minimize the volume of the cavity, and was sealed as in previous experiments. Hydrogen, occluded in the cavity during pickling, was released during firing and when blisters appeared over the thinner wall (⅛-in.) the piece was withdrawn. In a few minutes the blistered enamel was exploded from the piece by the evolution of hydrogen which was now in supersaturated solution in the wall. With passing time, the gas spread farther from the cavity and the effusion became weaker, with the result that smaller chips, or scales, formed and the scales were seated higher in

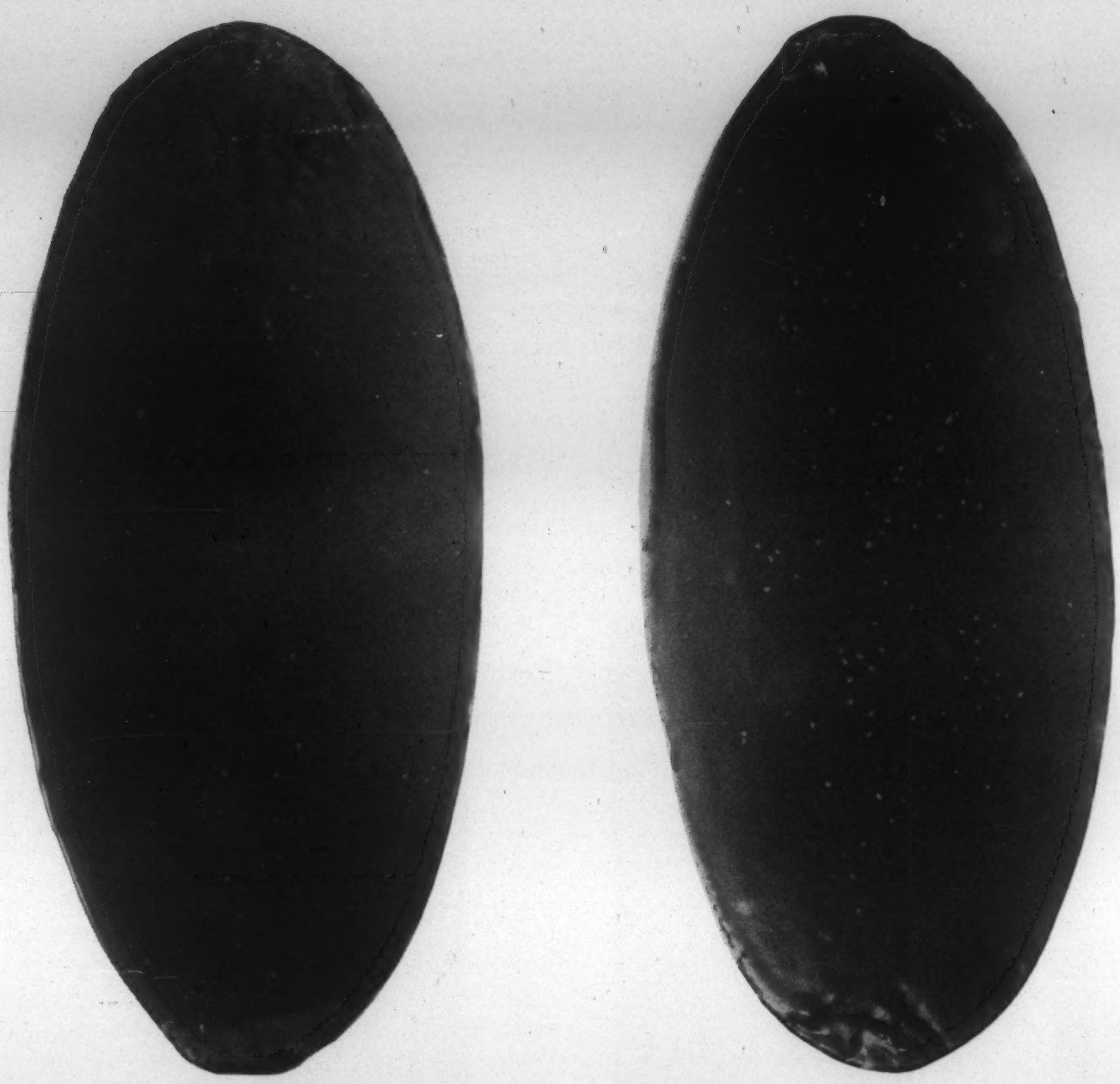
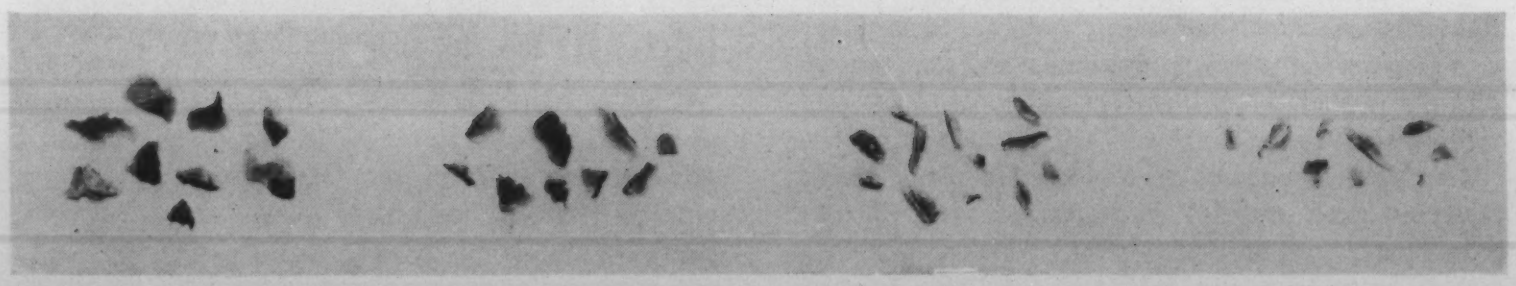


Fig. 28. (Left) Fishscales on compounded disc 6 weeks after firing with ground coat. (Right) Same disc after heating for 5 min. at 200 deg. C. (390° F.)

Fig. 29. The chronology of blistering and fishscaling illustrated by groups of scales exploded by hydrogen from an enameled specimen and collected after intervals as noted.

29a



29B

Fig. 30. Steel sheet coated on one side with Glyptal lacquer and cathodically electrolyzed. Hydrogen absorbed by steel on bare side of sheet has diffused through steel and blistered lacquer.

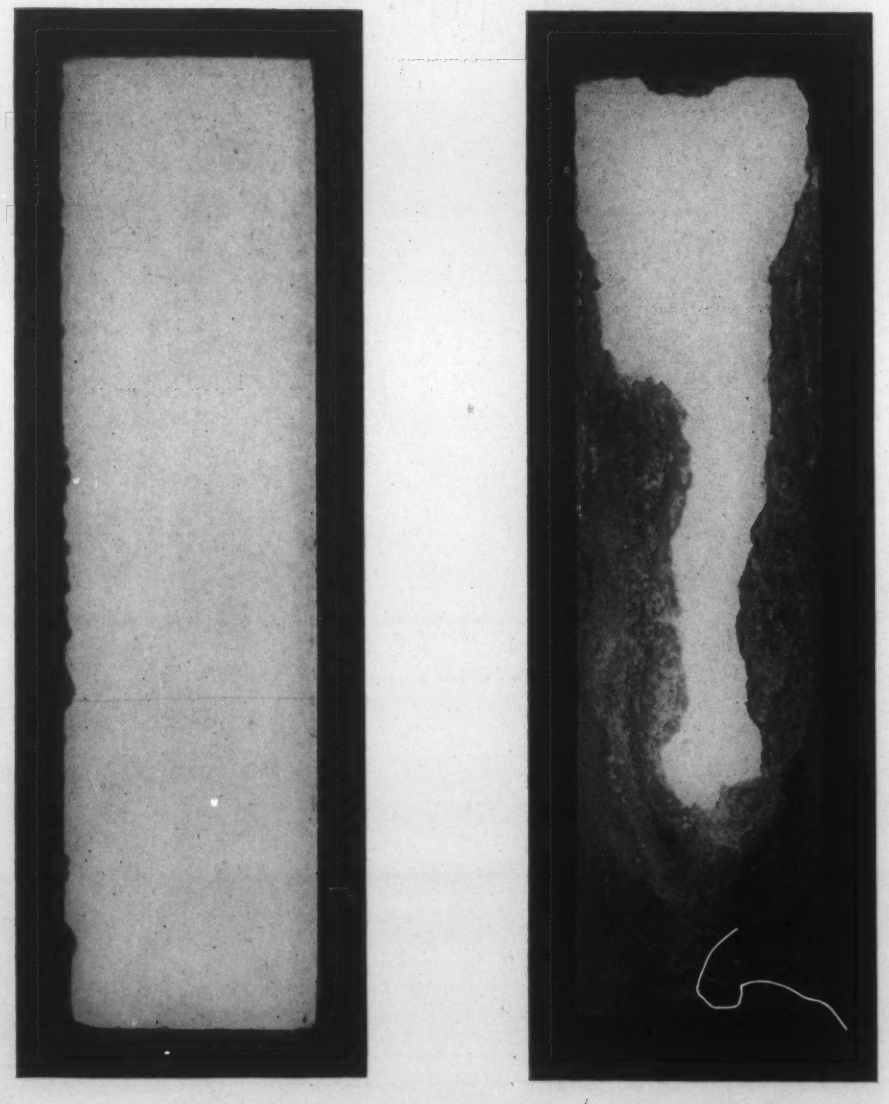


Fig. 31. Porcelain enamel on steel sheet removed by the explosive effect of hydrogen absorbed during cathodic electrolysis in very dilute acid electrolyte. The excessive hydrogen absorption blistered the sheet. (Left) Original strip with metal exposed only at sheared edges. (Center) Partially de-scaled. (Right) De-scaled.

the layer of enamel, indicating that the permeability was gaining comparative importance and that the gas diffused farther through the enamel before rupturing pressures developed.

Chipping of enamel on cast iron is less frequent than on steel probably because hydrogen diffuses through cast iron only with great difficulty when iron carbide is present, and ferrite is not likely to contain much hydrogen.

Defects in Paint and Resinous Coatings

The relations here are evident from the prior discussions. Blistering and lifting (See Fig. 30), and perhaps cracking, may be caused by hydrogen effusing from the steel base, and it is true that some steels show abnormalities in this regard which have not been well explained and which bear suggestive likeness to the relation between flakes and shatter

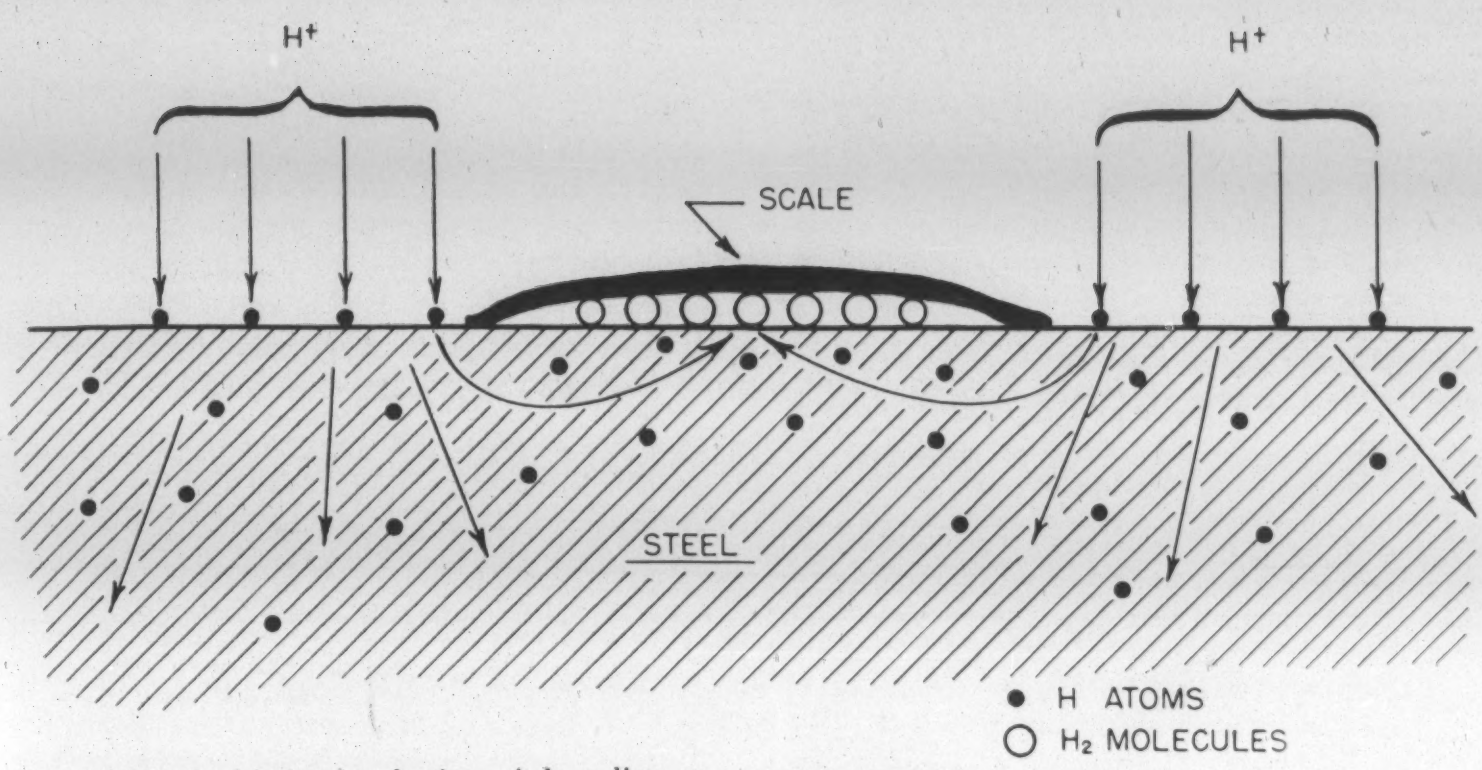


Fig. 32. Sketch showing mechanism of de-scaling action by hydrogen absorption and subsequent effusion.

cracks, or hydrogen-caused enamel defects, and the steel-making process. The defects are important particularly because they may initiate corrosion.

De-Enameling and De-Scaling

An interesting point has developed in regard to the de-scaling action of acid pickling and cathodic electrolysis. The de-scaling properties of acid are generally attributed to (1) solution of the scale in the acid and (2) the explosive action of hydrogen evolved when the acid seeps through the scale and attacks the iron. There is a third mechanism that has been overlooked, and that is (3) the explosive action of hydrogen that has entered the metal at exposed areas, diffused through the metal and has reappeared at unexposed areas underneath scale where the partial pressure of atomic hydrogen is zero.

Enamel, which is impervious to electrolyte, can be removed in nearly neutral solutions by cathodic electrolysis (See Fig. 31), if metal is exposed at some point to the hydrogen atoms—the sheared edges in the case of the specimen shown. The mechanism, shown by sketch in Fig. 32, may be very effective in explaining why moist hydrogen at elevated temperatures de-scales iron more rapidly than dry hydrogen, for the moisture reaction will increase the rate of hydrogen absorption by the metal, as has been shown throughout the present work and particularly elsewhere in the case of welding,[6] and the dissolved hydrogen will diffuse to areas underneath scale because the partial pressure there is a minimum. The rapid diffusibility of hydrogen in iron at elevated temperatures could enable such a function to become important.

Conclusions

(1) The hydrogen content of cast iron is markedly increased during melting by moisture in the atmosphere, in the rust on scrap and in raw materials in the charge, and during casting by moisture and hydrocarbons in the mold.

(2) The hydrogen in cast iron is closely associated with cementite, and is released from the cementite during heating to cause boiling and pinholing in vitreous enamel coatings. At 725 deg. C. (1340° F.) carbon-oxygen reactions, upon which the defects have generally been blamed, are inoperative. The "chill layer" seems important in enameling only because this layer contains hydrogen.

(3) The hydrogen can be effectively removed from cast iron by bubbling dry nitrogen through the melt previous to casting in dry molds with the result that no blistering or pinholing occurs during enameling at 725° C. (1340° F.).

(4) Effusion of hydrogen from steel is likewise the principal cause of boiling phenomena in sheet steel enameling; and at ordinary temperatures effusion of the same gas is the principal cause of chipping and scaling phenomena.

(5) Diffusion of hydrogen in rolled steel occurs preferentially within the rolling plane. The resulting effusion at edges of sheet and plate aggravates defects that are common to coatings on steel.

(6) Small amounts of moisture, particularly at elevated temperatures, are prolific sources of hydrogen absorption by steel and iron.

(7) The impurities that constitute steel change the characteristics of the Iron-Hydrogen System so that hydrogen in steel is not removed by classic heat treatments designed for removing hydrogen from iron. At 870 deg. C. (1600° F.) carbon still exerts a slight restraining force upon re-solution of hydro-

gen from internal occlusion, and oxides show strong retention.

(8) Oxidized surfaces and the presence of elements that poison catalysis of the reaction: $2H \rightarrow H_2$ greatly increase hydrogen absorption by steel during acid pickling and cathodic electrolysis. Effects of temperature, acid concentration, current density and inhibitors are significant; and there are interesting differences between pickling in hydrochloric and in sulphuric acid solutions. Cathodic electrolysis in alkaline or in acid solutions effects similar hydrogen absorption.

(9) Effusion of hydrogen from steel during electroplating may cause "gas pits"; and effusion after plating may cause blistering and lifting.

(10) Paint and resinous coatings on steel are affected much as is electroplate by hydrogen effusion, and the defects are significant because they may incept corrosion.

(11) De-scaling by acid pickling or cathodic electrolysis is in part effected by the explosive action of hydrogen that enters the metal at bared areas, diffuses through the metal and re-appears underneath scale or coating, where the partial pressure of atomic hydrogen is a minimum.

ACKNOWLEDGMENT:

Acknowledgment is made to Battelle Memorial Institute for the support of this work as a part of its program of fundamental research.

Recovery of Indium From Waste Liquors

THERE ARE NUMEROUS CASES where the recovery of the metal indium from old plating solutions, rinse water, etc., is not only possible but economical. In fact, the Indium Corp. of America, 60 East 42d Street, New York, has been doing this for some time. Conditions have developed so that the company has found it advisable to make public a method for this recovery so that others interested can apply it. It has been perfected by J. R. Dyer, Jr., technical director of the corporation.

The metals which may be found in the plating solutions, rinse water, etc. are: Indium, cadmium, lead, tin, copper, zinc, silver, iron, nickel and also some silica. The organic substances present include sodium and potassium cyanide, dextrose, filter paper, etc.

The equipment recommended to carry out the recovery method includes evaporating dishes, plating tanks, ovens, a furnace; dishes, tanks and crucibles made of glass, fused silica, fire clay or perhaps stainless steel, as well as filter presses of the suction or pressure types.

Details of the Procedure

In general the recovery procedure, as developed by Mr. Dyer, is as follows:

A. Water is eliminated by evaporation.
B. Organic materials are destroyed by ignition at temperatures approximately 700 deg., with good draft hoods and plenty of air over ignition surfaces.
C. Silver, silica and some lead are eliminated by solution of the residue after ignition with hydrochloric acid, filtering and washing with pure cold water. Silver chloride, some lead chloride and silica remain on the filter. Remaining impurities and indium are in solution.
D. Copper, cadmium, zinc and nickel are separated from indium, iron and tin by precipitating these metals from solution with excess of ammonium hydroxide. Filter and wash with ammonia water. The filter retains indium, iron and tin hydroxides. The filtrate containing copper, cadmium and zinc in solution is discarded.
E. Indium, iron and tin hydroxides are dissolved in a strong solution of hydrochloric acid and the solution subjected to a plating current of about 7½ volts. The cathode will have all the indium, a possible trace of iron, tin and nickel. The cathode is then made the anode in sulphuric acid electrolyte and the indium again plated out. Tin, nickel and iron will remain in solution. The indium will be of high purity with a possible trace of iron.

Iron is hard to keep out of the recovered indium metal, therefore it is highly desirable to shun it in the waste water solutions as much as possible, says Mr. Dyer. In case the waste water is badly contaminated it may be necessary to resort to precipitation of the indium by chemical transference under "E" by adding "Mossy Zinc" and filtering under acid conditions. The iron remains in solution, the filter will retain the indium and tin together with an excess of zinc. These solids are then dissolved in hydrochloric acid and subjected to the procedure as outlined above.

From Old Plating Baths

For the experiments on the recovery of indium from old plating baths, the following procedure, according to Mr. Dyer, is particularly adaptable:

> The solutions are first evaporated to dryness and then subjected to a mild ignition, that is, until all the organic matter has burned off. Then the temperature is raised until the cyanide and carbonate salts fuse, and the temperature is maintained until the melt is quiet. The molten melt may then be poured into molds, or allowed to solidify in the crucible. Upon cooling it will be found that the indium has been reduced to metal and will be segregated at the bottom of the mold. The molds are then dissolved in water and the metallic indium, silica, etc. filtered off. These may then be dissolved in hydrochloric acid and subjected to electrolysis for further purification.
>
> The solution should be carefully acidified under a good fume hood and any indium therein recovered by precipitating as indium hydroxide or ammonia. This may then be reclaimed as outlined above.

It is stated that it is possible by this method to recover almost the entire amount of indium, except in such instances where there is a large amount of iron present in the bath. In such cases the recovery is stated to be at least 75 to 80 per cent of the indium.

EUGENE (JACK) PHILLIPS, 1117 Cleckler South, Fort Worth, Texas, winner of first prize of $5,000 in the Revere Award for the idea doing most to help speed America's industrial defense program. Tall and lanky, Phillips is 33 years old and employed as senior radio electrician with the C. A. A. central depot at Fort Worth. When a close friend, Captain Jerry Marshall, crashed in Arkansas in landing an airplane, Phillips immediately set to work on his prize winning idea—an improved method of blind landing. He studied nights, gave up car, vacations and other pleasures for necessary equipment. His wife predicts most of the prize money will be spent for new equipment. He has three children, Patricia, 7; Kenneth, 4; James, 8 months.

The men and management of Revere Copper and Brass Incorporated are proud that the first Award of $5,000 goes to a man like Phillips. We also wish to thank the thousands of other American workmen for their splendid loyalty and cooperation in this effort to speed up industrial defense. Revere Copper and Brass Incorporated, 230 Park Avenue, New York.

. . . Carbon Molybdenum Steel has proved its economy for steam power plant service.

Operating savings obtained from high steam temperatures and pressures would justify using expensive steels to avoid steam line trouble. Fortunately, an inexpensive Carbon-Molybdenum (0.50% Mo) steel does the job.

Its creep strength up to 1000° F, plus its easy weldability, make for light, leak-proof lines. The use of thinner sections sometimes reduces the already small cost differential over unalloyed steels.

Write for technical book, "Molybdenum in Steel".

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

Climax Molybdenum Company
500 Fifth Avenue New York City

MOLY

METALLURGICAL ENGINEERING NEWS

Equipment
Finishes
Materials
Methods
Processes
Products

Alloys
Applications
Designs
People
Plants
Societies

Powder Metallurgy

Fabrication by powder metallurgy where feasible has a special appeal today to metallurgical production and design engineers, for the method is capable of producing parts on a mass-production scale and of doing this with only a minimum of machining. The expanding story of this most modern high-production method has recently added two bright new chapters—the development and commercial availability of porous metal filters and diffusers in various shapes, and a patented process for pressing powders in a partial vacuum.

Porous Metal Filters, etc.

For purposes of filtration or flow control in such industrial equipment as pumps, refrigerators, fuel lines, lubricating systems, etc., engineers have used metal screens, diffusing plates, cloth filters, ceramics, glass filters, and so on. A new and radically "different" addition to this group is "Porex", a porous material made by powder metallurgy, and developed by *Moraine Products Div.*, General Motors Corp., Dayton, Ohio.

The new material is a porous metal, the porosity of which can be controlled within narrow limits up to 50% void by volume. Tensile strengths up to 10,000 lbs, per sq. in. are obtainable.

The material is not readily machined or ground, although sizing can be employed to meet unusually narrow tolerances. A tolerance of 1½% on a given dimension is met in general practice.

The chief functions of Porex are to break up into small streams or masses the main flow of material; to remove undesired materials; to separate 2 fluids; and to serve as a diffusing medium. All its physical characteristics can be varied within limits to suit specific applications.

Present applications are in protective devices to remove harmful particles from fuel oil, diesel oil, refrigerants and natural gas passing through small, cloggable orifices, and in devices for controlling chemical and physical processes involving fluids.

The material is at present available in discs, sheets, cylinders, truncated cones, special shapes and inserts.

Vacuum Pressing

The pressing of metal powders (discussed in our Dec. 1940 issue, p. 744) is complicated by such things as the inability of metal powders to flow freely, the entrapment of gas or air during compression, the development of planes of weakness in the compact, etc.

According to *Hardy Metallurgical Co.*, New York, many of these difficulties can now be overcome by evacuating the powder before compression and by evacuating the mold into which the powders are pressed—as covered in U. S. Patent No. 2,198,612.

Many powders that will flow but slowly under atmospheric conditions, will flow readily when air or gases present between the particles are removed by evacuation, it is said. This improved flow permits more rapid filling of the mold, and better filling of cavities and angles in complicated shapes.

Other advantages claimed are the attainment of more uniform density through elimination of planes of weakness, and better diffusion in sintering because of the less-oxidized surfaces of the particles.

New Source of Carbonyl Iron

Carbonyl iron powder, principally for electrical products requiring an iron powder of highest purity, is now being made in an American plant, that of the General Aniline Works at Grasselli, N. J.

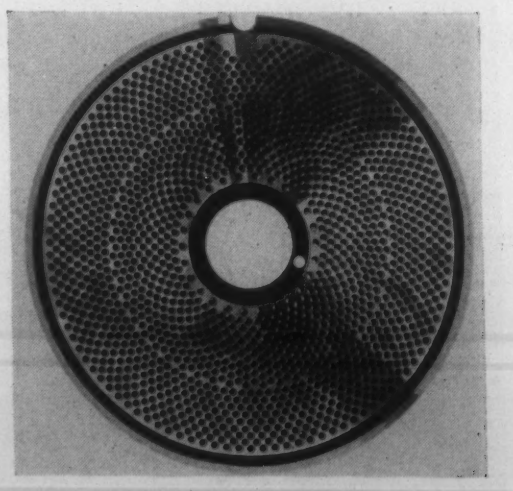
Grades of this carbonyl iron powder for other powder metallurgy applications will also be available, it is said. The selling agent for these powders is *Advance Solvents & Chemical Corp.*, 245 Fifth Ave., New York.

A Difficult Machining Job

A manufacturer of meat-grinder plates used in grinding hamburger meat (Korrect Kutting Mfg. Co., Glenn Ellyn, Ill.) experienced difficulty in drilling the holes in the disc through which the meat is forced by the screw.

As can be seen in the illustration, the holes are close together and sometimes a metal section between the holes would break out or crack in drilling. The holes are template-drilled with a high speed drill, multiple drilling being impracticable because of the close spacing between the holes.

After experimenting with several low-carbon steels for the disc material, this company finally standardized on "Speed Case", a free-machining open-hearth carburizing steel plate material containing controlled amounts of manganese and sulphur. On the 8¾ in. diam. disc shown, drilling time with Speed Case (a product of *W. J. Holliday & Co.*, Hammond, Ind.) was only 45.5% of that required for S.A.E. 1020.



Furthermore, facing time was reduced to about 60% of its former length, and drill breakage and wear were cut nearly in half. The wall between holes broke only in isolated cases, so that rejects were held to a minimum.

(MORE NEWS ON P. 66)

FUSE FIRE AND

TO GET REFRACTORIES THAT STAND

Fused at white heat, fashioned to baffle time, are the raw materials of Norton refractory products.

But no less important than bauxite, magnesite, coke, or purest silica sand, is the spark of *research*, Norton Ingredient Number One, which first fits the refractory material to the job and then makes it *stay there*.

Norton engineers, world's only *specialists* in electric-furnace-fused refractories, know that it takes the fire of practical imagination, the spark of research to fuse many variables into a refractory product that will fill your particular requirements.

Do you want porosity — *plus* resistance to crumbling? Strength and chemical inertness? A contact for melts that is non-oxidizing? Permeability without loss of strength?

Whatever your problem, when you buy a Norton refractory product, you get the single-minded attention of Norton's scientific and sales engineering staffs. You get a dynamic response to *your* problem, based on years of *specific* research for Norton customers.

IMAGES OF HEATED STEEL SEEN THROUGH LASTING TUBES

Costly, special alloy "sighting tubes" to observe and control furnace temperatures, frequently had to be replaced owing to oxidation and scaling. Norton engineers, working with a leading instrument manufacturer, devised silicon carbide CRYSTOLON tubes which filled the bill. Result: months of satisfactory service, longer tube life, lower tube costs.

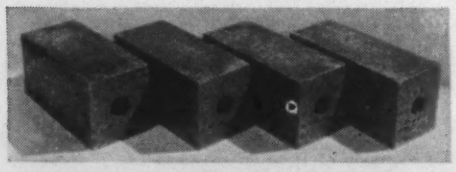
BRAIN

D THE GAFF..!

FIRING LINE NEWS

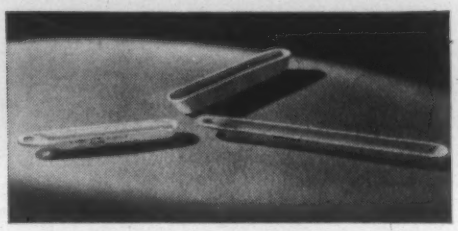
Crystolon Hearth Plates Make Your Furnace Bigger without Changing Its Size!

Bigger production capacity for your furnaces is possible when you switch to CRYSTOLON hearth plates, thinner because they are made of industry's strongest refractory material, silicon carbide. Naturally, the silicon carbide base means also that constant abrasion by heavy metal shapes results in very slow wear. Abrasion is the meat of CRYSTOLON products. Hence — amazingly long life, lower maintenance costs, and best of all, prevention of shut-downs for repairs. Even *this* doesn't tell you all the dividends you get from CRYSTOLON hearth plates. Their unsurpassed, rarely-matched heat conductivity cuts your fuel bills, transmits B.T.U.'s from fuel to metal quicker, with less waste.



Slag Meets Its Master in CRYSTOLON Slag Hole Blocks for Malleable Iron

Bonded densely together, the tiny silicon carbide crystals of CRYSTOLON slag hole blocks give a smooth, non-permeable surface that baffles slag seeking to take hold. Whatever the slag action, either by corrosion or erosion, the resistance of these CRYSTOLON blocks is astonishing. As for the heat of the slags, CRYSTOLON refractories thrive at temperatures up to 1650° without spalling or softening.



Combustion Boats with 9 Lives for Carbon Determinations

By lining a Norton Combustion Boat with R.R. ALUNDUM Grain (thus protecting it from softened metal, oxides and slag), you can use it over and over in carbon determinations. The great refractoriness of ALUNDUM material (up to 2050°C.) protects your boat from being shattered by heat, thus saving boat replacements and preventing loss of sample. Boats made of a special mix (coarse RA 98) carried in stock for determination of graphitic carbon in pig iron. Where steel analyses are performed constantly, special "Heavy-Duty" Combustion Boats are indicated. Zircon Combustion Boats also carried. To intercept spattering metallic oxide during combustion — ALUNDUM Boat Shields (thin walled tubes) lengthen combustion tube life.

NORTON RESEARCH

Ingredient Number One in Longer Lived Refractory Products —

Refractory Shapes and Cements of CRYSTOLON (silicon carbide), ALUNDUM (fused alumina), and Fused Magnesia Grains

NORTON COMPANY, WORCESTER, MASS.

Aircraft Sheet Metal Work Speeded by Photo-Sensitive Sheets

The development of "Matte Transfer Film", photographic material for sensitizing metal plates, is announced by *Eastman Kodak Co.*, Rochester, N. Y.

With this film, engineering drawings can be printed either by contact or by projection on metal sheets so sensitized, and the processed plates bearing the photographic image can be sent to the template department to be cut out and used as a pattern. Cutting is done by a saw or mechanical shears.

In this way the costly and time-consuming step of making the layouts on metal by hand from the blueprints, or the necessity of duplicate inspection, is said to be avoided. Also, copies of a drawing can be produced for checking purposes, for blueprints, by using photographic tracing cloth, or for use in redesigning a part.

Lockheed Aircraft Corp. has made satisfactory use of enlargements of mechanical drawings on photo-sensitized metal plates, the drawings being made directly on lacquered metal sheets. The drawings are photographed on glass plates in a special camera and the glass negatives enlarged onto the photo-sensitive metal sheets.

Photo-templates as large as 4 ft. x 12 ft. have been made in this way. The most simple and effective means of producing sheets of photo-sensitive metal is to laminate Matte Transfer Film to lacquered metal sheets. The maximum film width so far available is 34½ in.

According to Lockheed, the use of this film has contributed largely to reducing aircraft production cost by about $20,000 a model.

● Metallurgical design engineers in the electrical manufacturing industries who are often faced with the need for a resistor material with a negative temperature coefficient of resistance (to compensate for resistance increases at high temperatures in an electrical system) will be interested in a new line of negative t.c. resistors made by *Keystone Carbon Co.*, 1935 State St., St. Mary's, Pa.

Andrews Quality

PROVED AT ALL THREE CRITICAL POINTS

A IN THE STEEL PLANT

A IN YOUR PRODUCTION

A IN PRODUCT PERFORMANCE

ANDREWS STEEL

It is not enough to prove the quality of the bar, billet or slab at the Andrews plant in the laboratory. That is but the initial test. The second is equally important—how Andrews steel acts under your production processes and methods, and how well it fits into the requirements of your product. The third, performance, is the vital trial ground. This is the most critical and exacting of all, where your product must demonstrate its ability to give trouble-free, dependable, day-in and day-out service.

Andrews steel is manufactured with this third great test in mind. That is why so many Andrews customers find it to their advantage to standardize on Andrews steel—and enjoy the benefits of triple-proved quality at all three critical points—in the steel plant—in your production—in the hands of the consumer.

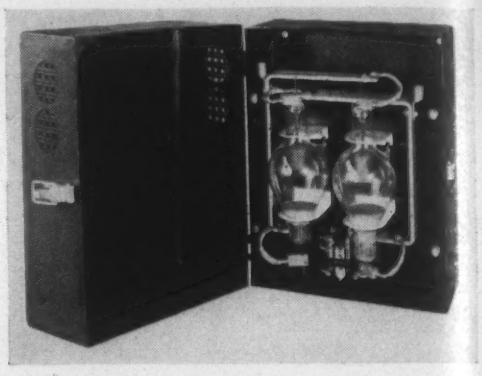
THE ANDREWS STEEL CO.
NEWPORT, KENTUCKY

DIVISIONS
THE NEWPORT ROLLING MILL COMPANY
THE GLOBE IRON ROOFING & CORRUGATING CO.

ANDREWS PRODUCTS IN CARBON AND ALLOY STEEL: Bars • Plates • Universal Mill Plates • Sheet Bars • Billets • Blooms • Slabs

Resistance Welder Contactor

A new tube contactor for resistance welders, announced by *Weltronic Corp.*, E. Outer Dr., Detroit, features simplicity of installation (no water connections) and applicability on small welding equipment previously outside the range of capacity of the electronic contactors.



Designed primarily for use with spot, projection and butt welders, the new "Stat-o-Tron" contactor requires only 4 simple electrical connections to make a field installation. The contactor is available with or without firing relay. Tubes will operate on 220, 440 or 550 volts without any internal changes in the contactor. In addition, the contactor can be used with loads as low as 5 kva.

Insulating Firebrick

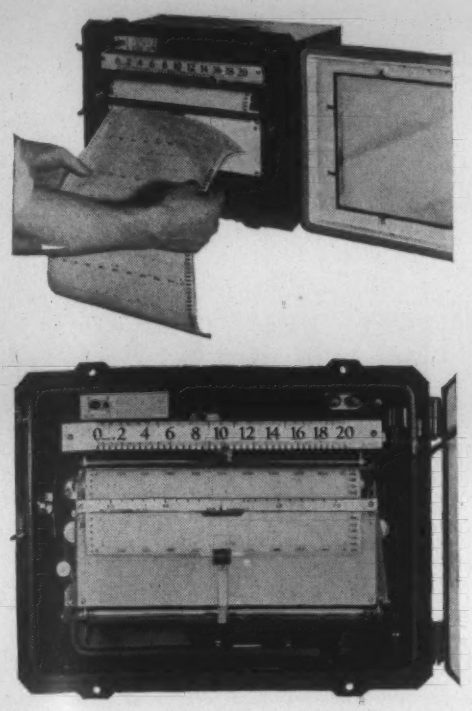
A new line of insulating firebrick for use at 1600-2600 deg. F. is announced by *Johns-Manville Inc.*, 22 E. 40th St., New York. These brick are designed for direct exposure in a variety of furnaces and ovens not subject to slag action or mechanical abuse.

The new insulating firebrick are produced from a plastic refractory clay and an organic filler which, after being burnt out during manufacturing gives a uniform controlled pore structure with a combination of light weight, strength and high insulating value.

The brick are finished in 4 temperature limits: JM-16 for special service to 1600 deg. F. and for back-up service to 2000 deg. F.; and JM-20, JM-23 and JM-26 for exposed or back-up temperatures to 2000, 2300 and 2600 deg. F., respectively.

Strip-Chart Tear-Off Device

A new tear-off feature can now be supplied by *C. J. Tagliabue Mfg. Co.*, Brooklyn, N. Y., for Celectray Recorders and Recorder-Controllers. It consists of a tear-



off bar and a re-roll with clip and tape; the clip firmly grips the chart after a chart section has been removed.

This feature is particularly useful for daily records as well as for a complete record of any batch or run. These short chart strips can easily be filed for ready reference.

New Blackening Processes

Two new electrolytic blackening processes that between them cover practically all important industrial metals and are claimed to fill the need created by the tight situation in nickel-plating salts, have recently been announced.

Alrose Chemical Co., Providence, R. I., (originators of the "Jetal" process for blackening iron and steel) announced the new "Electro-Jetal" process for producing a black finish on copper by anodic oxidation. According to the manufacturer, any metal that can be copper-plated can be blackened by this process.

After pre-plating with copper, the products are treated in a special anodic oxidizing bath for 2-5 min. The resulting velvety black surface readily absorbs oil, wax or lacquer to give a non-porous, rust-proof finish said to be comparable to ordinary nickel plate.

The new Electro-Jetal bath can be operated at any temperature below that of boiling water, and ordinary steel tanks can be employed. The chemical cost, exclusive of the copper plate, is about 25c per sq. ft. of surface. The process is reported to be in use by one company alone for treating over 260,000 small parts per day.

An electrolytic blackening process that can be used on a variety of metals, including aluminum, steel, stainless steel, zinc, cadmium, nickel, silver, gold, lead, tin, etc., is announced by *Enthone Co.*, New Haven, Conn. The new process, called "Electro-Ebonol", is said to produce parts that are harder, blacker and more adherent than black nickel.

The Electro-Ebonol salts are supplied readily for use, and a solution of 12 oz. per gal. of water is used at 140-190 deg. F. Current densities are from ½ to 5 amps. per sq. ft. at 1-2 volts, depending on the set-up.

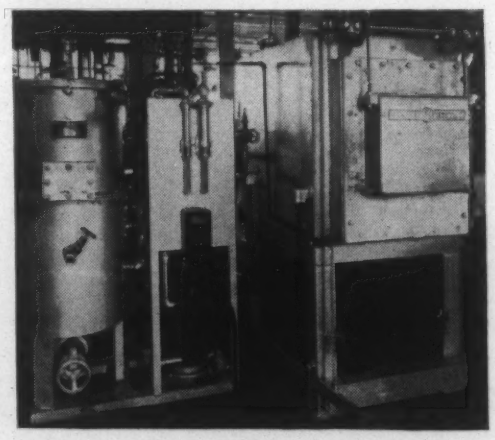
For this process, anodes may be of carbon or of stainless steel; tanks may be of wood, stainless steel, ceramic-ware or Monel metal.

The work is cleaned for blackening just as with ordinary plating, and the black coating is deposited in 30 sec. to 3 min. The throwing power is claimed to be very high.

● A line of low cost kickless welding cables of "full concentric" design for reduced current loss, and with positive and negative strands wound at steep helical angles to increase the ease of flexing and reduce wear is announced by *Progressive Welder Co.*, 3050 E. Outer Dr., Detroit.

Box-Type Electric Furnaces

For the heat treatment of tools, dies and small steel parts, a new line of box-type furnaces is announced by *General Electric Co.*, Schenectady. The furnaces are elec-



trically heated (with compensating units in front and rear of the furnace), and with suitable atmospheres are claimed to give scale-free heat treatment without decarburization.

The new furnaces may be employed for temperatures up to 2000 deg. F., and are designed especially for use with "Drycolene", G-E's special atmosphere gas (see our May issue, p. 593). Other atmospheres may, however, be employed.

There are four furnaces in the new box-type line, the largest having a motor-operated door instead of a foot-pedal-operated door. A high-velocity flame curtain prevents the loss of "atmosphere" when the door is open. The largest furnace has 27-in. inside width, 54-in. working length, and 20-in. door height.

● To protect aluminum alloy castings against corrosion caused by water-vapor condensation, an emulsion of paraffin wax and "Flexo Wax C," made with diglycol stearate S, can be sprayed on the castings to leave a protective, water-repellent film, according to *Glyco Products Co., Inc.*, 230 King St., Brooklyn, N. Y.

Refining Scrap Aluminum

The great demand for aluminum has resulted in the collection of all types of scrap, even scrap that heretofore was considered not usable because of the nature of the alloys present. According to *Charles Hardy, Inc.*, 420 Lexington Ave., New York, metallic calcium can be very useful to scrap re-melters in difficult secondary metal-refining operations of this type.

It is claimed, for example, that tin, bismuth, silicon, antimony, lead, etc. have an affinity for calcium. The calcium compounds formed with these "impurities" are eliminated by entering the slag. The amount of metallic calcium required is comparatively small.

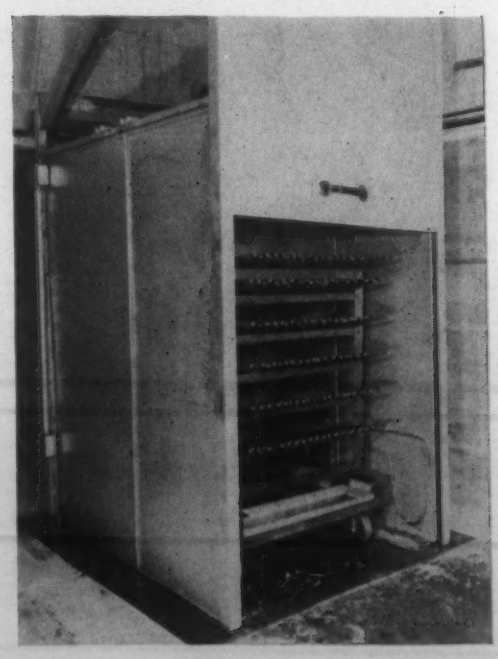
Prior to the European war, metallic calcium was available only through importation. Since then, however, a domestic plant has been erected and metallic calcium is now available in commercial quantities to meet the demand for it as a refining agent for magnesium, aluminum, iron and steel.

● According to the *James F. Lincoln Arc Welding Foundation*, Cleveland, pressure on the nation's steel supply could be eased somewhat by greater use of welding. Figures compiled by the Foundation show that an average of 18% less steel is required for welded products as compared to riveted.

Heating Units for Curing Bearings

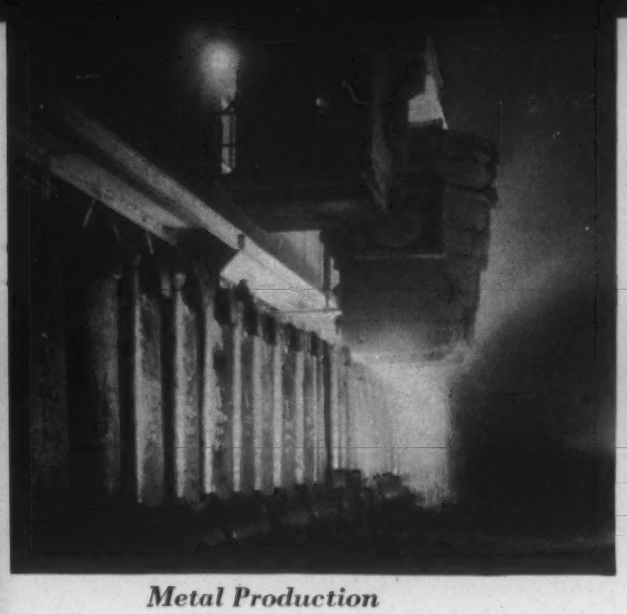
An interesting application of electric heating, for curing flexible bearings made of combinations of metals and non-metals, is found in the use by Harris Products Co., Cleveland, of 6 *General Electric* 2500-watt Calrod heating units for curing "Torflex" bearings.

This rotative type of bearing assembly consists of a metal sleeve, under which a rubber and then a graphite-bronze sleeve well coated with petrolatum is inserted. 100 of these bearings are placed on a rack and wheeled into the Calrod-heated oven

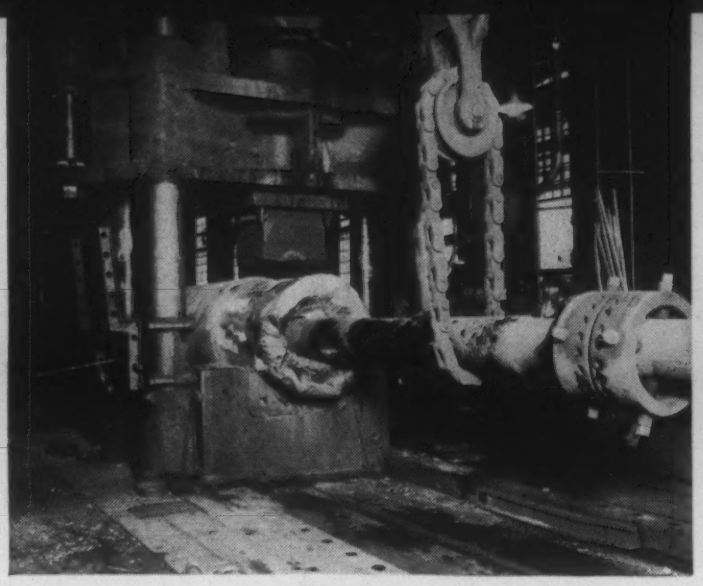


for a 15-hr. treatment at 150 deg. F., which bakes out the petrolatum.

(MORE NEWS ON P. 70)



Metal Production



Forging

Heat Treating

YOUR CUSTOMERS' #1

WILL PROVIDE THE KEY EDITORIAL FEATURE

"FASTER PRODUCTION FOR DEFENSE!"—*that's* what Industry wants today, and *that's* the theme of METALS AND ALLOYS' October issue.

How to make it *faster*, and still make it *better*,—that's the chief consideration that governs Industry's thinking and buying today. And that goes for both Defense and Civilian needs. Every survey proves this point. Every factory of importance illustrates it. Each passing day emphasizes it.

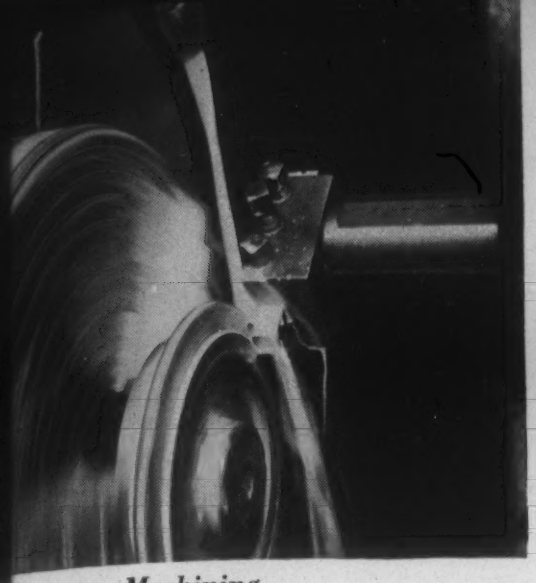
And—the advertising pages of industrial Business Papers prove that Advertisers are recognizing the importance of the theme to which METALS AND ALLOYS will devote its "Metal Show" issue.

Here's How* METALS AND ALLOYS *will handle the theme—and Why! We're going to give our readers—the Metallurgical Engineers—straight-out, *factual* information on the *faster production* of the Defense and Civilian products whose buying specifications and production are their daily job.

We're going to do this with short, signed articles—and a lot of them. They'll cover every metallurgical engineering operation of importance, and many products. They'll skip the preamble and get down to practical *facts* on how to do it *better* and *faster*.

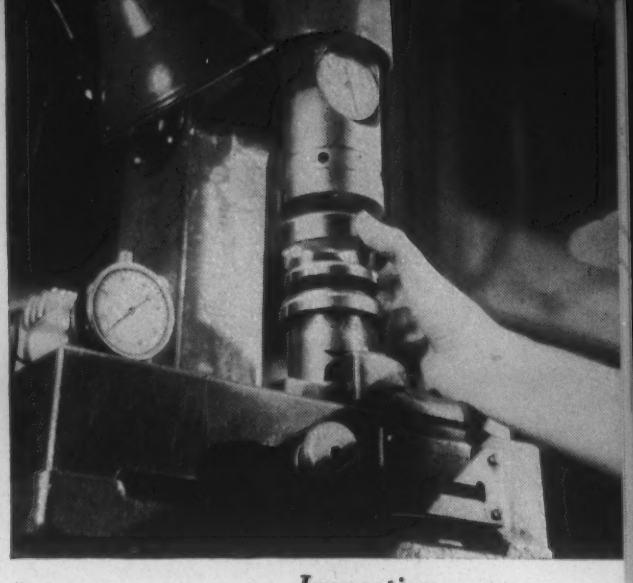
We're going to handle the subject this way for a definite reason. We do not believe that engineers who count as customers and prospects of yours, want discussions in general terms—or slightly revised transpositions of well-known practices to armament products.

Here's what the October issue will do for your customers and prospects. It will give the Metallurgical Engineer authentic, *useful* information on actual aids to faster production of, or with, metals. In so doing—and in conjunction with your advertising—it cannot fail to guide and influence him in his *buying* specifications.



Machining

Welding



Inspection

BUYING INTEREST

FOR OCTOBER'S METALS AND ALLOYS

Here's what this big, practical October issue will do for Advertisers. It will lend *added selling punch* to your advertising that tells the Metallurgical Engineer how your product can help him turn out *more* material of *better* quality *faster*...and it does so in practical terms of your customer's No. 1 *buying* interest.

Because the editorial will tell *how*, it will lead to *buying specifications* and *action* for the materials or tools with which to do it.

Because the articles will be terse, practical, comprehensive, timely, they will insure more readers per copy, and more time spent per reader throughout the entire issue. And—you'll get the bonus of added circulation, interest and readership through the Metal Show at Philadelphia, October 20-24.

AND—HERE'S WHAT TO DO TO MAKE YOUR ADVERTISING DO MORE! Get your reservation in now for space in the big October "Metal Show Issue" of METALS AND ALLOYS. Copy and cuts can be taken up to September 15th, complete plates as late as September 20th.

If you want more information on Editorial, or Advertising rates, etc., phone or write: 330 West 42nd Street, New York City—BRyant 9-4430. 310 S. Michigan Avenue, Chicago—Harrison 7218. 1133 Leader Building, Cleveland—Prospect 5583.

For the record: *A METALLURGICAL ENGINEER* deals in the *practical* application of metallurgy to production—and has a major hand in *specifying* and *buying*. Often his title is Plant Superintendent —or, Production Foreman—or, Chief Engineer.

YOU'LL FIND THEM IN INDUSTRIES SUCH AS: Ferrous and non-ferrous metal production—Automotive—Aviation—Marine—Ordnance—Electrical—Rail—Hardware—Machinery —Structural—Process Industries Equipment.

THEY DEAL WITH OPERATIONS SUCH AS: Melting—Casting—Rolling—Drawing—Forging—Forming—Heat Treating—Machining—Welding—Finishing—Inspection—Engineering Design and Metal Selection.

ABC ABP

Metals and Alloys

BUYING SPECIFICATIONS BEGIN WITH THE METALLURGICAL ENGINEER

Reinhold Publishing Corporation · 330 West 42nd Street · New York City

Oil Reclaiming Systems

The existing uncertainty as to the oil-supply situation, particularly in the East, highlights the importance of prolonging the life of cutting oils and lubricants as much as possible. A practical way of doing this is through such oil-clarifying and reclaiming systems as the Gale Interceptor, manufactured by *Gale Oil Separator Co., Inc.*, Chrysler Bldg., New York.

Systems of this type have long been used not only to effect economies in oil consumption but to increase production of machine tools and to assure a superlative finish on the machined parts. The Gale Interceptor operates entirely by gravity and has no moving parts.

When the cutting oil or coolant flows from the automatic machine into the Gale, the mixture of grindings, metal particles and oil is directed downward into the Interceptor, and is at once broken up by a specially-designed breaker wedge. The breaker wedge directs the lighter oil to the surface and the heavier material to the bottom of the unit.

The heavier material is riffled and rolled, and flows into a bucket which is easily removed. The Interceptor can replace the present settling tanks, or the outlet from a Gale unit can be directed into an existing pump section with little wasted installation time.

Portable Acetylene Generator

A new portable acetylene generator for use in oxyacetylene welding and cutting has just been announced by *Linde Air Products Co.*, 30 E. 42nd St., New York. This generator, known as the Oxweld MP-10, will deliver 30 cu. ft. of acetylene per hr. and is suitable for welding metal up to ⅜ in. thick, and for cutting steel up to 5 in. thick.

It is designed for maximum portability, from a standpoint of weight and height, and can readily be moved about the shop or away from the shop for outside jobs. The generator can be recharged speedily, and is simple and easy to operate, it is said.

Generation of acetylene is started, set for regular automatic operation, and stopped, by rotating the single pair of

operating handles at the top of the generator. The pressure of acetylene delivered to the blow-pipe is controlled by a regulator, which forms an integral part of the generator, and a separate pressure gage indicates at all times the pressure within the generating chamber.

The carbide hopper holds 15 lbs. of 14 ND carbide and is designed for easy recharging.

Heat-Protective Coating

With the increasing difficulty in obtaining heat-resisting alloys and steels, heat-treating engineers will be interested in a new type of heat-resisting coating—called "Metlsteel"—claimed to prevent corrosion and disintegration of metal parts exposed to gaseous atmosphere at furnace temperatures.

The new coating, a product of *Porcelain Enamel & Mfg. Co.*, Baltimore, Md., is applied as a liquid coating and prevents oxidation up to temperatures in excess of 1500 deg. F., it is said.

EF Rotary Carburizers Gas or Compound

For carburizing miscellaneous small and medium size products—uniformly and economically — using either gas or compound—EF rotary type carburizers are meeting the most exacting requirements. Products such as gears, pinions, nuts, bolts, screws, roller and ball bearing parts, chain links and many other products are being handled in this equipment.

EF rotary carburizers are built in sizes with capacities ranging from 500 to 1000 lbs. per hour.

The furnaces in the foreground accommodate net charges of 550 lbs. each—the several furnaces in the background handle charges of 1000 lbs. each.

All sizes are supported on trunnions and have suitable tilting mechanism to enable furnace, with maximum charges, to be easily tilted by one operator. The contents of retorts may be quickly discharged into containers or quenched as desired. Additional information on carburizers or on furnaces for any other process gladly furnished on request.

We build Gas Fired, Oil Fired and Electric Furnaces—For any Product, Process or Production.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Personals

Melvin C. Harris has been elevated to the newly-created position of district manager of Pittsburgh-area plants of Allegheny Ludlum Steel Corp. . . . He is succeeded as manager of the company's Brackenridge plant by *Carl B. Pollock*. . . . *Geo. W. Evans* has been named to follow Mr. Pollock as general superintendent at Brackenridge.

Also, Allegheny Ludlum has set up a new Development Engineering Department, managed by *W. E. Griffiths*, with *W. F. Detwiler, Jr.* as assistant manager. . . . *E. J. Hergenroether* has resigned as metallurgist of the Detroit office of International Nickel Co., Inc. to join the staff of the Conservation Section of the Production Division of the OPM at Washington.

N. C. Fick has been transferred from the United States Steel Corp. Research Laboratories at Kearny, N. J., to the Metallurgy Dept., Gary Works, Carnegie-Illinois Steel Corp. . . . *J. Tucker MacKenzie, Jr.* is now employed in the Metallurgical Laboratory of the Wood works of the Carnegie-Illinois Steel Corp. at McKeesport, Pa.

Francis T. McGuire, who has been a Teaching Fellow in the Dept. of Metallurgy at Notre Dame, is now assistant professor of metallurgy in the University of Kentucky, Lexington, Ky. . . . *C. W. MacGregor*, associate professor of applied mechanics, Mass. Inst. of Technology, was awarded the Charles B. Dudley medal at the annual meeting of the Am. Soc. for Testing Materials last month, for his 1940 paper, "The Tension Test."

● A new air-dry finish, known as "Amron" has been developed by *United States Stoneware Co.*, Akron, Ohio. It is a vinylite-base lacquer and does not require baking. Amron primer contains metal-corrosion-inhibiting ingredients, it is said.

Meetings and Expositions

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention. San Diego, Calif. July 23-25, 1941.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific Coast convention. Yellowstone National Park. Aug. 27-29, 1941.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting. Atlantic City, N. J. Sept. 8-12, 1941.

FREE SERVICE DEPARTMENT

Replies to box numbers should be addressed care of METALS AND ALLOYS, *330 W. 42nd. St., New York.*

POSITION WANTED: Metallurgist, 33, married. M. S. in physical metallurgy. Eight years' research experience. Aluminum, tin, copper, lead alloys. Developed new bearing alloy, lead base die casting alloy, lead base alloy for coating steel. Thoroughly experienced in metallography, X-ray technique, physical testing. Some patent experience, also mechanical engineer degree. Now employed in industrial research laboratory. Desires change. Box MA-16.

HELP WANTED: Plant metallurgist, preferably 30 to 40 years of age, with non-ferrous rolling mill experience and good technical background. Excellent opportunity for right man. State training, experience and salary. Box MA-17.

HELP WANTED: Salesman wanted in eastern territory by seamless tube mill. Must have technical training and steel product sales experience, preferably carbon and alloy tubing. Apply with full particulars to Box MA-18.

POSITION WANTED: Metallurgical engineer, B.S. and M.S. Nine years aircraft development and construction, eight years petroleum refinery maintenance and construction. Experienced in welding, shop methods, specifications and codes, corrosion and protective coatings. Box MA-19.

POSITION WANTED: Metallurgical engineer with extensive technical training and industrial experience in foundry, forge, heat treating, welding. Plant control, research and development. Box MA-20.

HELP WANTED: Non-ferrous furnace operator. Give age, experience and references. Box MA-21.

HELP WANTED: Sales Manager by prominent industrial furnace manufacturer. Must be able to effectively organize sales force, be familiar with heat treating practices and sales advertising. Give personal details, photo and references in first letter. Box MA-22.

In the electric welding industry an annual production rate of 275,000,000 pounds of electrodes (approximately double that of 1940) is still not enough to meet the requirements of the new defense program.

In spite of increased production facilities—our own new plant at East Chicago, for example, has increased our capacity 50% and is soon to be stepped up to still greater output—it is practically impossible for most electrode suppliers to maintain normal deliveries.

May we suggest, therefore, that ***you order electrodes when you order your steel.*** Thus you can be more certain of having electrodes on hand when the steel is received.

The Murex engineering department is available for consultation as to ways and means of speeding up welding and reducing costs.

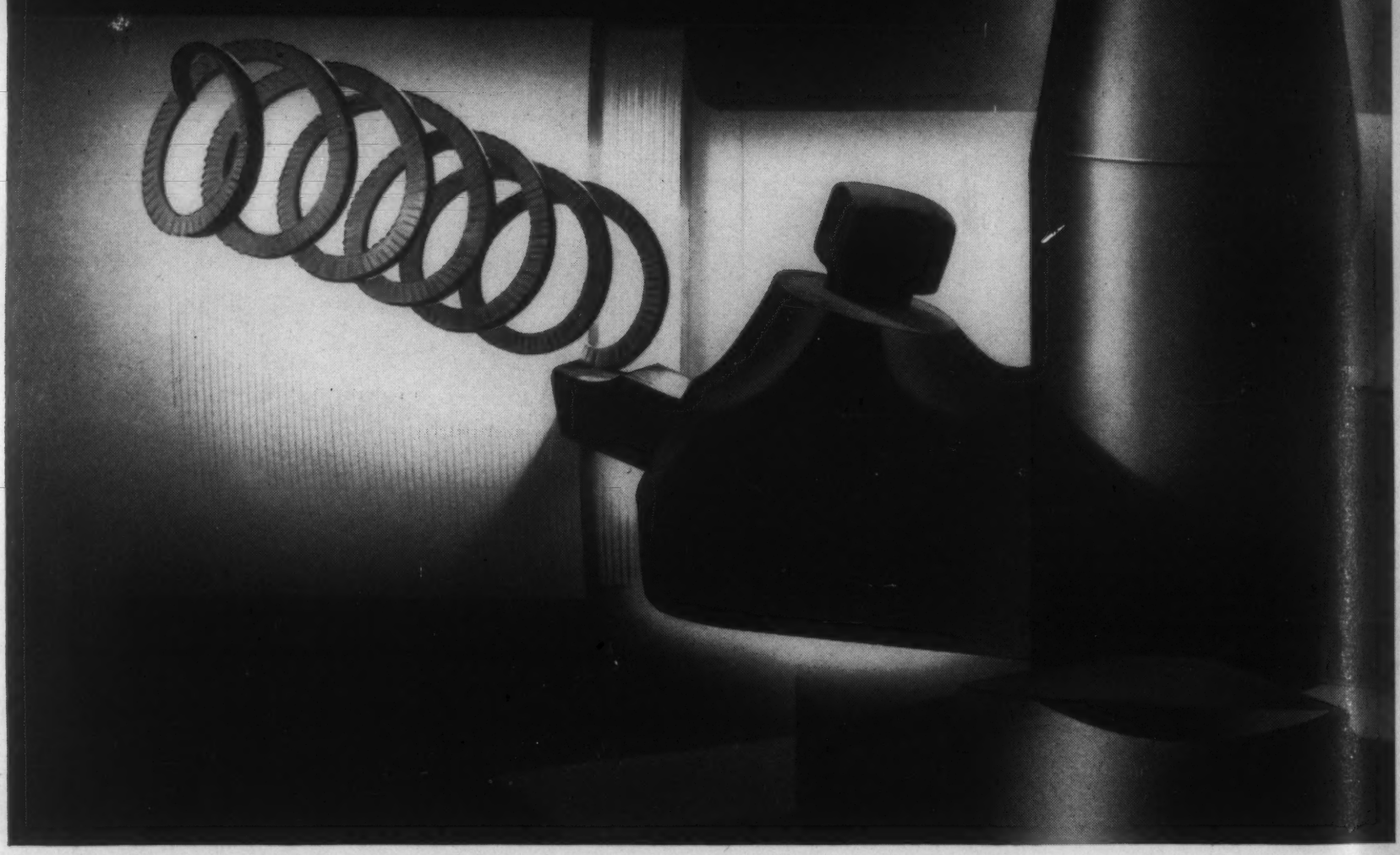
MUREX HEAVY COATED ELECTRODES

METAL & THERMIT CORPORATION • 120 BROADWAY, NEW YORK

ALBANY • CHICAGO • PITTSBURGH • SO. SAN FRANCISCO • TORONTO

THERMIT WELDING — STANDARD FOR 40 YEARS FOR WELDING RAILS AND HEAVY EQUIPMENT

. . . Ask your supplier about Molybdenum high speed steels. Experience proves they pay.



You know what you want from your cutting tools. Here's what users are getting from molybdenum high speed steels, in comparison with the tungsten types.

Equivalent cutting properties Greater toughness Lower cost

These are facts — with nine years' experience in thousands of shops to back them up. Check cost and performance records with any user you like. See your supplier for the proper analysis and heat treatment for your requirements.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

METALLURGICAL ENGINEERING

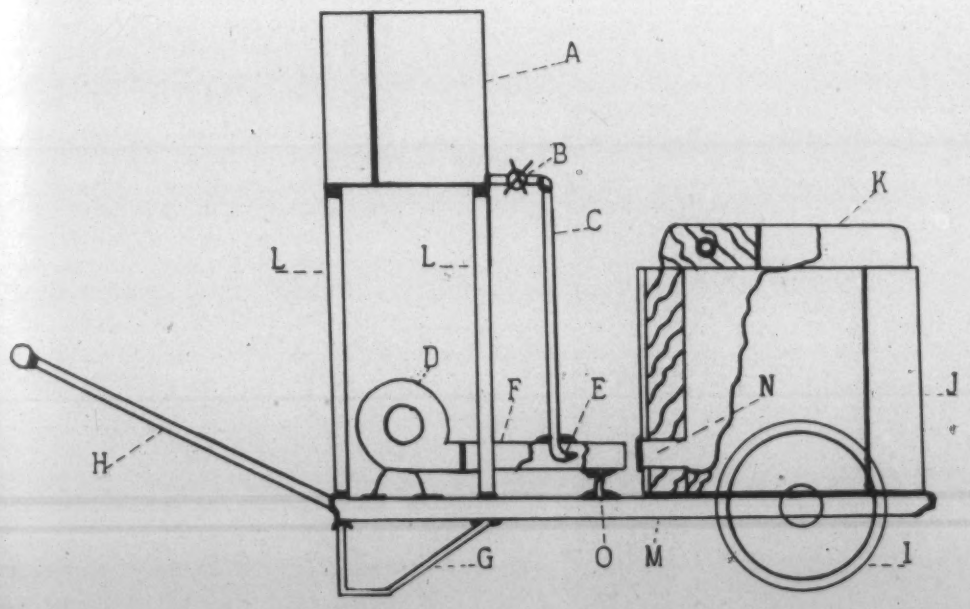
shop notes

Small Portable Crucible Furnace

By C. P. Philpot
Clemson College

Many foundries could use a small crucible furnace for small melting jobs that now have to be done in a large stationary furnace. With the simplicity and ease of arc-welded construction, a very useful portable furnace can be built from standard shapes and odd pieces of discarded material for less than $20—the cost varying according to available materials.

Simply follow the sketch (furnished by Hobart Bros. Co., Troy, Ohio) for assembling and welding the furnace. Owing to the relatively small size of the finished job, all welds were positioned for down-hand welding.



A—5 gal. kerosene tank fabricated from 20-gage black sheet steel by welding.

B—Kerosene control valve.

C—⅛ in. black iron pipe, end turned at E to right angle and welded closed—$\frac{1}{16}$ in. hole drilled for orifice.

D—Blower from old domestic vacuum cleaner—supports welded to frame M.

F—2 in. diam. steel pipe clamped to the vacuum cleaner blower and supported by welding to the frame at O.

G—⅜ in. x 1 in. flat steel legs welded to frame.

H—1 in. diam. steel pipe handle welded to frame.

I—14 in. diam. fabricated steel wheels, all-welded construction and mounted on a ⅝ in. steel axle welded to frame.

J—Open-topped steel tank, 3 ft. diam. by 2 ft. high, fabricated from $\frac{1}{16}$ in. sheet steel by welding and welded frame. (This tank is later lined with 4 in. of refractory fire brick—sides and bottom.)

K—Old truck brake drum for furnace lid—⅜ in. steel rods welded in to reinforce the clay lining in lid.

L—⅛ in. x 1 in. x 1 in. angle supports for tank—welded to the frame at bottom and the tank at top.

M—¼ in. x 1½ in. angle iron frame, 5 ft. long by 3 ft. wide, welded at corners and braced by welded diagonal braces.

N—2 in. diam. steel pipe welded to tank and extending through the lining into furnace.

No dimensions are given on the sketch since they may be varied to fit local conditions and the material at hand.

The operation of the furnace is very simple. Kerosene is atomized in a stream of rapidly moving air, and on entering the furnace burns with a flame hot enough to melt all of the low-temperature metals and even brass or bronze. The furnace itself is portable and may be used anywhere that a 110-volt current supply is available.

Saving Solder

by James Brinn

L. A. Cohn & Bro., Inc.

On soldering jobs where it is impossible to prevent excess solder from dropping on the floor, care should be taken to tin *only the upper* edge of the soldering iron.

In this way the solder first flows into the joint and then excess solder drops on the floor. If both sides of the iron are tinned, the liquid solder runs through and drops on the floor just as fast as it runs into the joint.

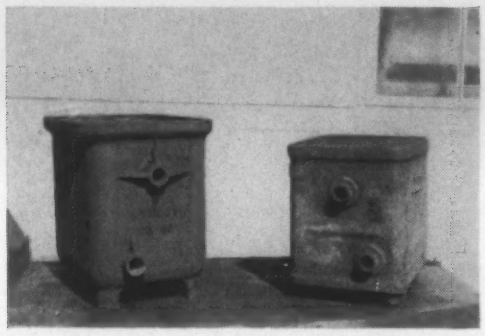
The ancient method of tempering springs in a hardening furnace is still a good trick where production is too small to justify a regular tempering furnace. A thin load of hardened springs, covered with quenching oil, is spread out in a long-handled wire-mesh basket. The basket is placed in the hardening furnace and shaken like popcorn until the quenching oil starts to flash, when the springs are immediately withdrawn, and shaken until the oil is all burnt off them.

—*Heat Treating Hints*,
Lindberg Engineering Co.

Useful Carburizing Box Design

Axelson Mfg. Co.
by E. F. Green

In the use of carburizing boxes of various shapes and sizes, we have found a real need for a better method to handle, lift and dump the boxes. About a year ago we adopted a box design that has since proved very satisfactory.



The design of the box is as illustrated herewith. It incorporates two pairs of trunnions into which will fit an ordinary pair of tongs. The upper trunnions are used to lift and move the boxes. The lower pair are used to dump, lift, and move the box.

The use of this type of box has greatly simplified our dumping operations. In addition to its utility, the box is much safer to use than the conventional box with side ribs.

In the photograph, the left-hand box is a casting, with the trunnions cast integral with the box. The right-hand box is a welded sheet box onto which are welded short cylindrical castings of heat resisting material. The trunnions may readily be welded to old boxes of various shapes with little or no trouble.

It would also be possible to vary the design and use of the trunnions in such a manner that only one set would be needed. This box design will not be patented.

Blocking Cracks in Steel Castings

St. John X-Ray Service, Inc.
by Herbert R. Isenburger

Even with the best design, practice or service, a crack may develop in a steel casting. In such cases, it isn't always necessary to reject or replace the part, if something like the following can be done.

A large crack was found (by X-ray examination) in a heavy steel casting. "Double Exposure" technique revealed that the crack was located near the outer surface of the wall of this particular casting. The end of the crack was clearly noticeable in the exograph, whereupon it was decided to arrest the crack by drilling a small hole through the end of the crack as located by means of the radiograph.

After the hole was drilled, the casting was submitted to a hydrostatic test at 3 times its normal working pressure and hammered for an hour during the test. Then the repaired section was re-X-rayed and the exograph, which is reproduced herewith, shows that the hole stopped the crack, since it did not develop any further during this severe pressure test.

Sit down and send without delay Your own Shop Notes to M. & A. And if they're good, we'll pay and pay!

Clean Abrasive for Blast Cleaning

by C. A. Snyder
American Foundry Equipment Co.

Peak metal-cleaning efficiency from abrasive blast cleaning equipment (air or airless) depends on keeping the metallic abrasive clean. Molding sand, scale and broken-down fines retard cleaning action and increase the rate of wear on the blasting machine. Failure to keep foreign material out of the abrasive can lower cleaning speed as much as 50 per cent.

A ventilating and dust collecting system of adequate capacity and correct design will maintain cleaning efficiency at a high level, *if the system is regularly inspected to be sure it is operating as recommended.* Here are some of the important points that are often overlooked in this periodic cleaning:

1. Don't allow the dust collector to become overloaded with dust—shake the tubes when needed. Hoppers should be emptied daily.
2. Check the condition of the tubes in the dust collector regularly to be sure they are not torn or damaged.
3. Check the vent piping at intervals (especially the horizontal pipe section) to make sure that deposits of dust have not accumulated through a drop in air velocity.
4. Check the belt on the suction fan occasionally to make sure there is no slippage. Be sure the fan is operating at the correct speed and in the right direction.
5. If the blast cleaning equipment is equipped with an abrasive separator, check it regularly, preferably once a day. The discharge orifice should be adjusted to provide as even a flow of dirty abrasive over the shed plate as possible, and no foreign material should be imprisoned in the slot. Also check the orifice to see that wires or refuse are not retarding the flow of abrasive through the separator.
6. Be sure that all cover plates and inspection doors are in place, particularly those on the abrasive separator, elevator head, and on the dust collector, otherwise air will be permitted to by-pass through these openings and seriously affect the efficiency of the dust collecting equipment.

Unsoundness in castings, particularly of the small repetition type, is often caused by the use of too small gates (to facilitate removal when the mold is knocked out). Unless there is a riser on each casting, the feeding stops as soon as the gate is solid; if the latter is too thin it will solidify first and cut off the main supply of metal from the castings, resulting in cavities or pressure unsoundness.

—*Fluxuations,*
Foundry Services, Inc.

Metallurgical Engineering Digest

FERROUS AND NON-FERROUS

ADVISORY EDITORS

C. H. HERTY .....*Iron and Steel Production*
G. L. CRAIG .....*Non-Ferrous Production*
J. W. BOLTON .....*Foundry Practice*
S. EPSTEIN .....*Rolling*
A. W. DEMMLER .....*Forging and Forming*
H. W. GRAHAM .....*Machining*
O. E. HARDER .....*Heat Treatment*
HORACE DREVER ...*Furnace, Refractories, Fuels*
E. V. DAVID .....*Welding and Cutting*
H. S. RAWDON .....*Finishing*
M. GENSAMER ....*Properties of Iron and Steel*
A. J. PHILLIPS ..*Properties of Non-Ferrous Metals*
V. V. KENDALL .....*Corrosion*
H. F. MOORE .....*Fatigue*
H. C. CROSS .....*Creep*
W. A. TUCKER .....*Testing*
L. REID .....*Magnetic Inspection*
G. R. HARRISON .....*Spectrographic Analysis*
J. S. MARSH .....*Ferrous Metallography*
C. S. BARRETT .....*Non-Ferrous Metallography*

ASSOCIATE EDITORS

A. A. Anderson, G. Ansel, W. H. Boynton, A. Brenner, Janet Briggs, W. H. Bruckner, J. C. Chaston, Frances Clark, A. W. Contieri, B. N. Daniloff, J. W. Donaldson, H. C. Duus, E. Fetz, J. D. Gat, B. W. Gonser, J. L. Gregg, G. E. Guellich, M. E. Haas, M. Hartenheim, C. E. Jackson, C. B. Jenni, J. B. Johnson, H. F. Kaiser, B. Z. Kamich, P. R. Kosting, A. I. Krynitsky, D. J. Martin, G. T. Motok, G. Neuendorff, Frank G. Norris, J. M. Noy, V. S. Polansky, H. W. Rathmann, P. C. Rosenthal, C. M. Saeger, Jr., M. Schrero, R. P. Seelig, A. U. Seybolt, N. Shibata, A. P. Som. O. R. Spies, B. H. Strom, H. F. Taylor, Cyril Wells, R. A. Witschey.

1. Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining. Open-Hearth, Bessemer, Electric-Furnace Melting Practice and Equipment. Melting and Manufacture of Non-Ferrous Metals and Alloys. Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill and Heavy Forging Practice. Foundry Practice, Furnaces, Equipment and Materials. Manufacture of Die-Castings.

2. Processing and Fabrication

Drop and Hammer Forging, Drawing, Extruding, Stamping and Machining. Age-Hardening, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Surface-Hardening and Tempering. Heating Furnaces, Refractories, Fuels and Auxiliaries. Welding, Flame-Cutting, Hard-facing, Brazing, Soldering and Riveting. Cleaning, Pickling, Electroplating, Galvanizing, Metallizing, Coloring and Non-Metallic Finishing.

3. Design and Applications

Physical and Mechanical Properties (including Fatigue and Creep). Corrosion and Wear. Engineering Design of Metal-incorporating Products. Selection of Metals and of Metal-Forms: Competition of Metals with Non-Metals. Specific Applications of Metals and Alloys.

4. Testing and Control

Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. X-ray and Magnetic Inspection. Spectrographic and Photoelastic Analysis. Corrosion- and Wear-Testing. Examination of Coatings. Surface Measurements. Metallographic Structure and Constitution.

1 Production

OF METALS, MILL PRODUCTS, CASTINGS

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining. Open-Hearth, Bessemer, Electric-Furnace Melting Practice and Equipment. Melting and Manufacture of Non-Ferrous Metals and Alloys. Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill and Heavy Forging Practice. Foundry Practice, Furnaces, Equipment and Materials. Manufacture of Die Castings.

Super-Duty Fire Brick

"Super Duty Fire Clay Brick." S. M. Swain. *Am. Refractories Inst.*, Bull. No. 75, Feb. 1941, 7 pp. Review.

"Super-duty fire-clay brick" are classified by the A.S.T.M. as fire clay brick having a pyrometric cone equivalent not lower than Cone 33 on the fired product, not more than 1% linear shrinkage in the permanent linear change test, schedule C (2912° F.) and not more than 4% loss in the panel spalling test (preheated at 3002° F.).

Because of the high purity of the bond clay, high resistance to abrasion is difficult to attain in super-duty brick. A special class of super-duty brick with greater resistance to abrasion but with a different combination of other physical properties is produced by firing to higher temperatures, which necessitates a higher cost for the brick.

The outstanding physical property of super-duty fire-clay brick is high resistance to spalling over the full range of temperatures at which they can be used.

The second outstanding characteristic is high resistance to slagging. Some fluxing agents react with these brick to form a glass with a relatively high softening point, because of the purity of the clay dissolved to form that glass. The high alumina content may make this glass viscous at operating temperatures and also causes the formation of an interface composed largely of mullite needles, which are slow to dissolve in added quantities of flux, thus forming a resistant layer protecting the remaining refractory.

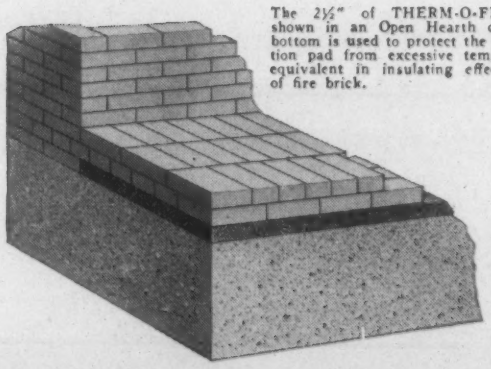
The greater resistance to slag erosion is demonstrated in the much greater resistance of super-duty than high-heat-duty fire-clay refractories in the side walls of malleable iron air furnace. Some fluxing agents, however, form low viscosity and low-melting glasses so that a knowledge of the fluxing ingredients is necessary in applying super-duty brick.

Their third outstanding property is their load-bearing ability at elevated temperatures, which allows their extensive use in severe applications such as division walls between regenerative chambers.

With correct application, the use of

Therm-O-flake
INSULATING CONCRETE

A Light Weight High Temperature Concrete with Double Insulating Value



The 2½" of THERM-O-FLAKE Concrete shown in an Open Hearth checker chamber bottom is used to protect the concrete foundation pad from excessive temperatures. It is equivalent in insulating effect to about 15" of fire brick.

Reduces usual insulating concrete thickness by about half.

Increases effective depths of flues and checkers in Open Hearth furnace construction.

Protects concrete foundation pads from excessive heat.

Allows increased magnesite thickness in Open Hearth bottoms.

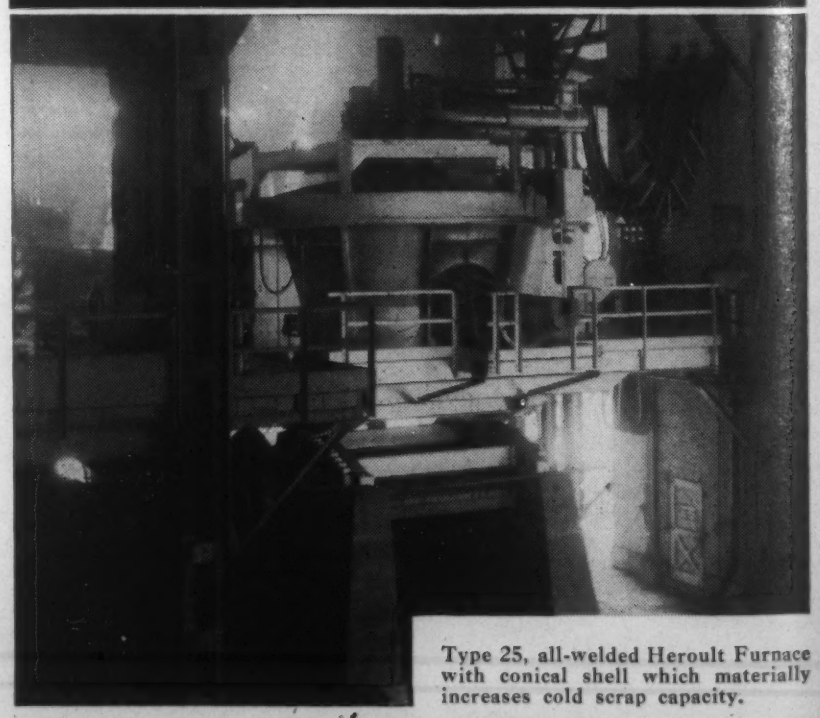
Smooths surface irregularities on Open Hearth bottom pans.

Write for Information and Prices

Other **Therm-O-flake** Products
Made from Exfoliated Vermiculite
Granules - Coating - Brick - Block

Illinois Clay Products Company
JOLIET, ILL.

Heroult ELECTRIC FURNACES



Type 25, all-welded Heroult Furnace with conical shell which materially increases cold scrap capacity.

For low-cost, efficient melting and refining of all kinds of ferrous materials by either basic or acid process—including alloy, tool, and forging steels, iron and steel castings. Any capacity from ½ ton to 100 tons; hand, chute, machine or drop-bottom bucket charging.

AMERICAN BRIDGE COMPANY
General Offices: Pittsburgh, Pa.
Offices in the larger cities
Columbia Steel Co., San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

HOW TO GET lead OUT OF feet

WE MEAN that you can get the lead out of the feet of any core room . . . and out of bake ovens, too . . . and cleaning rooms.

Whole flocks of foundries from this coast to that, and all in between, are doing it now . . . cutting costs . . . turning out more production . . . with higher quality. It's as simple as this!

Convenient-size Bag Is Easy to Handle

Just write your name in the handy coupon at the bottom of this page, pin it to your letterhead, and mail it to us *quickly*. We'll see that you get information and a sample of Truline* Binder, research's gift to foundrymen.

HOW TRULINE BINDER INCREASES PRODUCTION IN MANY FOUNDRIES

SAVES TIME ON BAKING Truline Binder bakes through quickly—increasing core oven output. Time saving is sometimes as much as 30%.

SAVES TIME ON CLEANING Cores collapse quickly; this makes cleaning faster. Some foundries have cut cleaning time 50% with Truline Binder.

SAVES TIME ON RAMMING Flowability of Truline Binder mix speeds ramming, particularly in green sand facings.

*Reg. U. S. Pat. Off., by Hercules Powder Co.

TRULINE BINDER
Reg. U. S. Pat.-Off.

NAVAL STORES DEPARTMENT

HERCULES POWDER COMPANY
Incorporated
WILMINGTON, DELAWARE

CHICAGO NEW YORK ST. LOUIS SALT LAKE CITY SAN FRANCISCO

HERCULES POWDER COMPANY
907 Market Street, Wilmington Delaware

Please send information about Truline Binder ☐

Please send a free trial sample ☐

*Name*_____

*Company*_____

*Street*_____

*City*_____ *State*_____

JJ-38

super-duty brick results in overall economies at relatively small increase in cost; the increased cost applies only to the brick, and therefore when installing and other factors are considered, the aggregate cost increase is even smaller. RAW (1)

Babbitting Rolling Mill Bearings

"Good Babbitting Practice Prevents Shutdowns." Park G. Bollinger (Am. Smelting & Refining Co.) *Blast Furnace & Steel Plant*, Vol. 29, Apr. 1941, pp. 425, 428. Practical.

The babbitt shop should be provided with thermometers or pyrometers. Babbitt metals should not be poured too hot, as the bearings are likely to be brittle. It is better, in the great majority of cases, to pour the bearing metal slightly under the recommended pouring temperatures. To obtain a tight sound bearing, shells and mandrels should always be preheated to 350°-400° F.

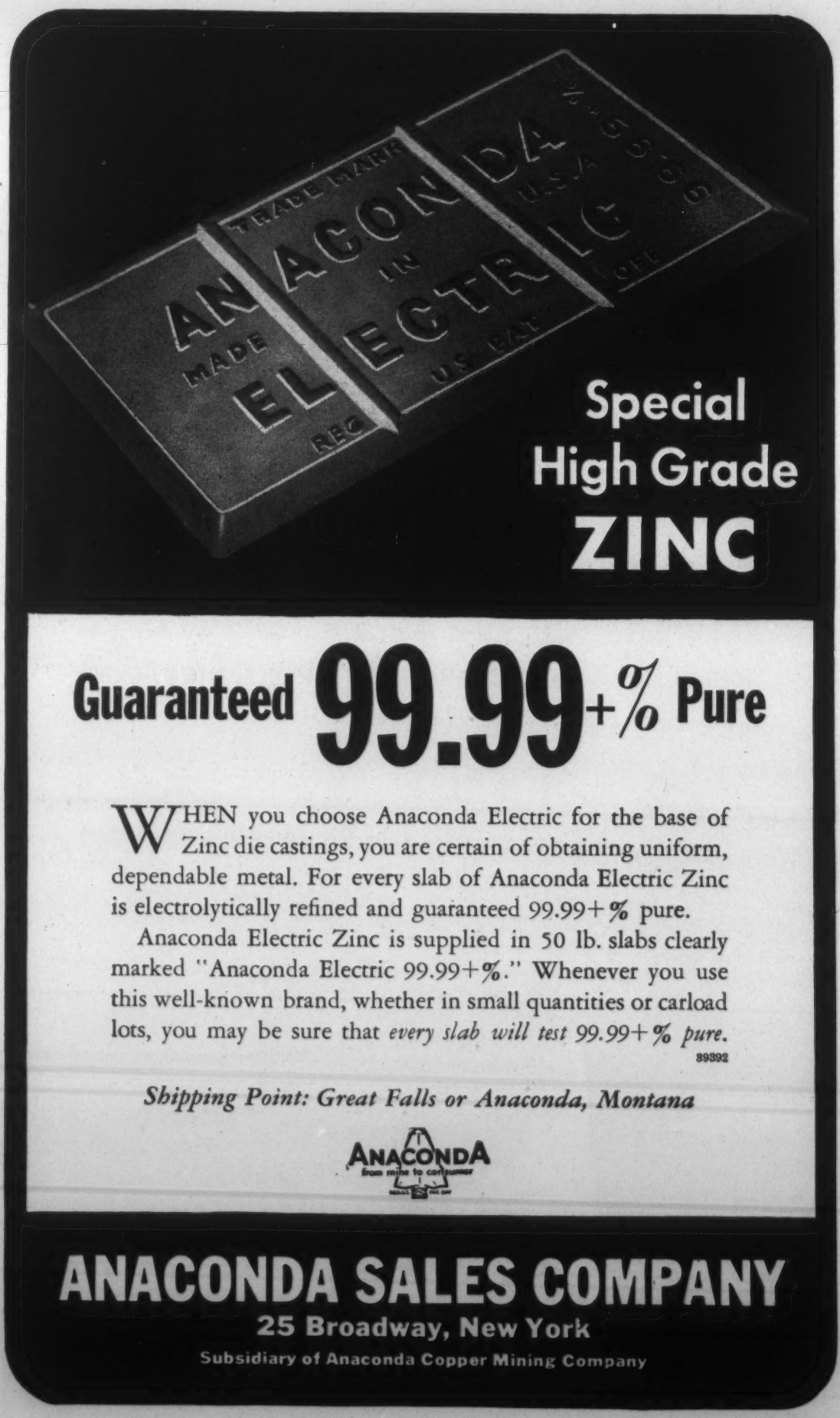
Continuous pouring of bearings is by far the best practice. While pouring by means of hand ladles is necessary in the case of small bearings, large bearings poured by this means will show seams, which often cause early cracking in service. One shop has "bottom-poured" bearings through a flat-bottom pot having a plug valve in the bottom near the edge. The valve was operated by means of a lever extending over the pot edge.

The condition of the bearing shells is very important. Cracks or holes in the shell permit oil or grease to work between the bearing metal and shell, resulting in weakening of the bearing. Shells should have ample anchorage grooves, preferably ragged ones, which should be dove-tailed and kept cleaned out. To prevent shells from becoming too deeply saturated with grease, they should be boiled out occasionally in suitable tanks.

Many roll-neck bearings have given better service after the bronze grids were removed, although in these cases the babbitt metal had a rather high compressive strength. Cold working of bearings before machining is advantageous but not always practical. Crank-pin bearings, especially when the shells have been tinned, are always benefited by light peening.

The tinning of shells is beneficial, but not always practical. Bearings subject to reciprocating motion should, if possible, be tinned.

Too large a number of babbitt metal types should be avoided, to obviate mixing. Generally, one good lead-base and one good tin-base babbitt should be sufficient. The prevalent practice is to use a pot mixture of ⅔ old metal and ⅓ new metal. A pinch of sal ammoniac is helpful in drossing the old metal, which should be analyzed periodically. Certain bearings, subject to severe service, should always be poured from all new metal. MS (1)



Guaranteed 99.99+% Pure

WHEN you choose Anaconda Electric for the base of Zinc die castings, you are certain of obtaining uniform, dependable metal. For every slab of Anaconda Electric Zinc is electrolytically refined and guaranteed 99.99+% pure.

Anaconda Electric Zinc is supplied in 50 lb. slabs clearly marked "Anaconda Electric 99.99+%." Whenever you use this well-known brand, whether in small quantities or carload lots, you may be sure that *every slab will test 99.99+% pure.*

89392

Shipping Point: Great Falls or Anaconda, Montana

ANACONDA
from mine to consumer

ANACONDA SALES COMPANY
25 Broadway, New York
Subsidiary of Anaconda Copper Mining Company

Flowability of Molding Sands

"Sand Testing with Special Reference to Flowability and Deformation." Wm. Y. Buchanan. *Foundry Trade J.*, Vol. 64, Apr. 17, 1941, pp. 263-266. Review discussion.

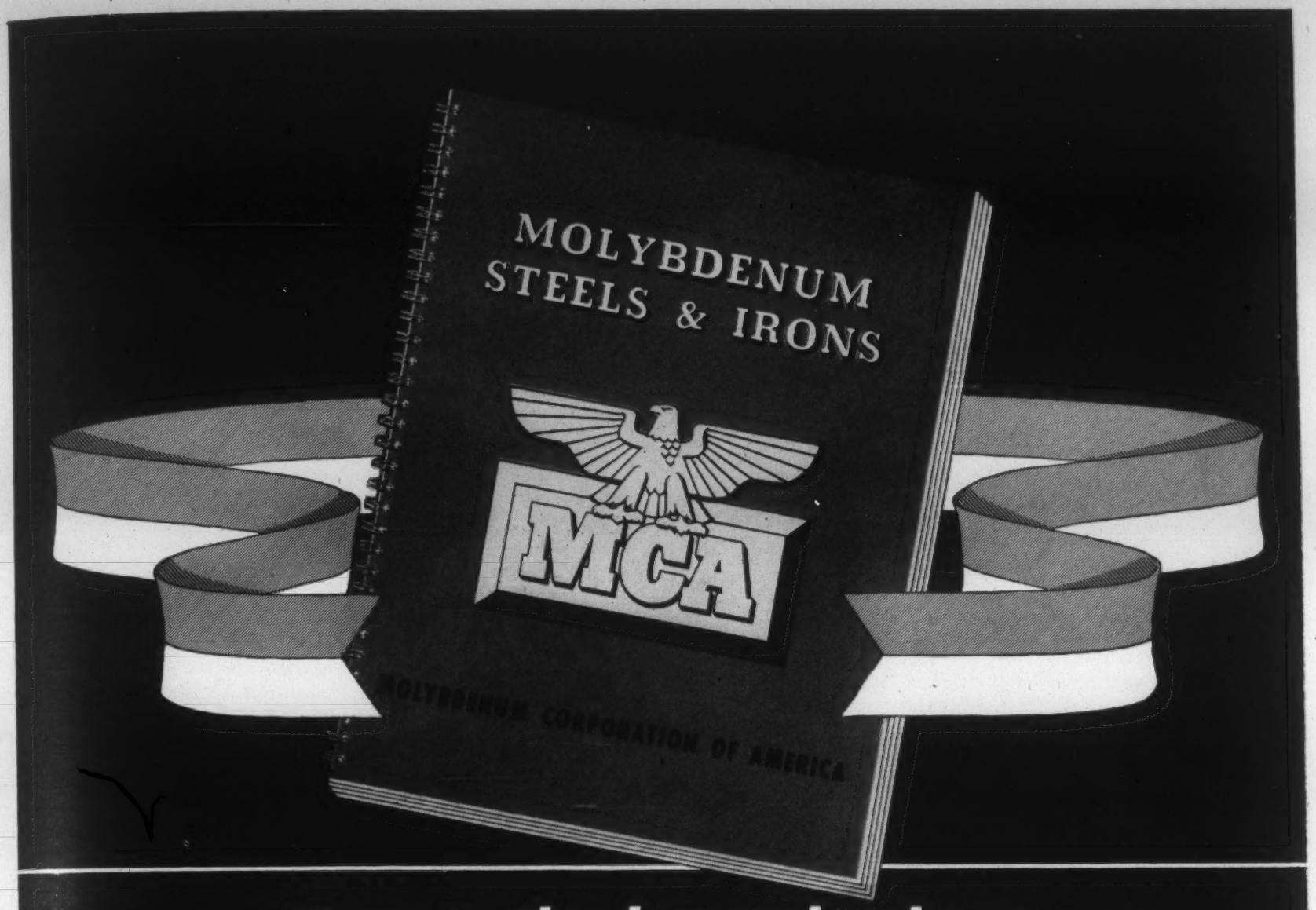
Dearden in his work examined the effect of moisture on clay-free sand as a foundation for his study of the general effect of moisture on molding sand (see Metals and Alloys, Vol. 10, July 1939, p. 404L5). The author doubts whether there is any practical significance in this line of research, since in no case is a molding sand composed of clay-free material and clean water.

However, it has been suggested that the effect of water additions on clay-free sands moves the intrinsic value of the A.F.A. method of making the test-piece. Some very definite conclusions have been accordingly drawn—for example, that silica and other clay-free sands would not ram any harder with increased moisture. This is in direct contradiction to the author's earlier statement that the A.F.A. test-piece is at all times subject to the effect of flowability in the sand being tested.

The author checked this, using Irvin sand for comparison, and it was found that a distinct flowability was present even in this type of sand. With three blows of the A.F.A. rammer, this sand is inclined to be over-rammed, and it would not be surprising to find the flowability of the sand masked in such tests.

Flowability is the property which enables sand to flow throughout the mass when ramming energy is applied to the outside of that mass. This property is possessed in a varying degree by all molding sands. Very high flowability is found in oil sand, bonded with, say, pure linseed oil and very low flowability in certain types of heavily-bonded "steel" sands.

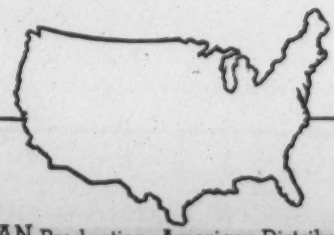
For machine molding, using well-finished pattern plates, a sand having good flow-



Here is the latest book on

MOLYBDENUM

The importance of Molybdenum to the American metallurgist is so great, under present conditions, that helpful information on the subject is desired by every technician concerned with the properties of irons and steels. To meet the demand for such information in compact and convenient form, the Molybdenum Corporation of America has prepared a treatise in three parts, dealing with Wrought Steels, Cast Steels, and Cast Irons respectively. In which are you interested? If you will reply, indicating your official connection, the desired pamphlet will be mailed you without delay. Apart from its own recognized standard uses, Molybdenum is capable of replacing other alloying elements in greater or less measure, without sacrificing any desired property in the resulting irons and steels. Your specific inquiries are invited.



AMERICAN Production, American Distribution, American Control—Completely Integrated.

Mines: Tucson, Arizona; Questa, New Mexico.

Smelting and Refining Works: York, Pa.; Washington, Pa.

Offices and Warehouses: Pittsburgh, New York, Chicago, Detroit, Los Angeles, Montreal.

Sales facilities, technical advice, ample stocks available.

MCA

MOLYBDENUM CORPORATION OF AMERICA

GRANT BUILDING, PITTSBURGH, PA.

USE MOORE RAPID *Lectromelt* FURNACES for MELTING REFINING SMELTING

Illustration shows top charge type LECTROMELT furnace with roof raised and rotated to one side to permit quick charging with drop bottom bucket.

LECTROMELT furnaces offer the rapid and economic means for the production of plain carbon and alloy steel ingots and castings as well as gray and malleable irons. Top charge and door charge types are both available. LECTROMELT furnaces are built in standard capacities from 25 pounds to 100 tons. Write for details.

PITTSBURGH LECTROMELT FURNACE CORP.
Foot 32nd St. Pittsburgh, Pa.

AID AMERICA'S DEFENSE PROGRAM

Metal is one of primary essentials of the Nation! Its conservation is vital to success.

Write for Bulletin "M1"

Tells how THIS METAL RECLAIMING MILL will end Non-Ferrous Metal Losses!

Reclaim Valuable Metal . .
at a cost of only 1/4c a pound!

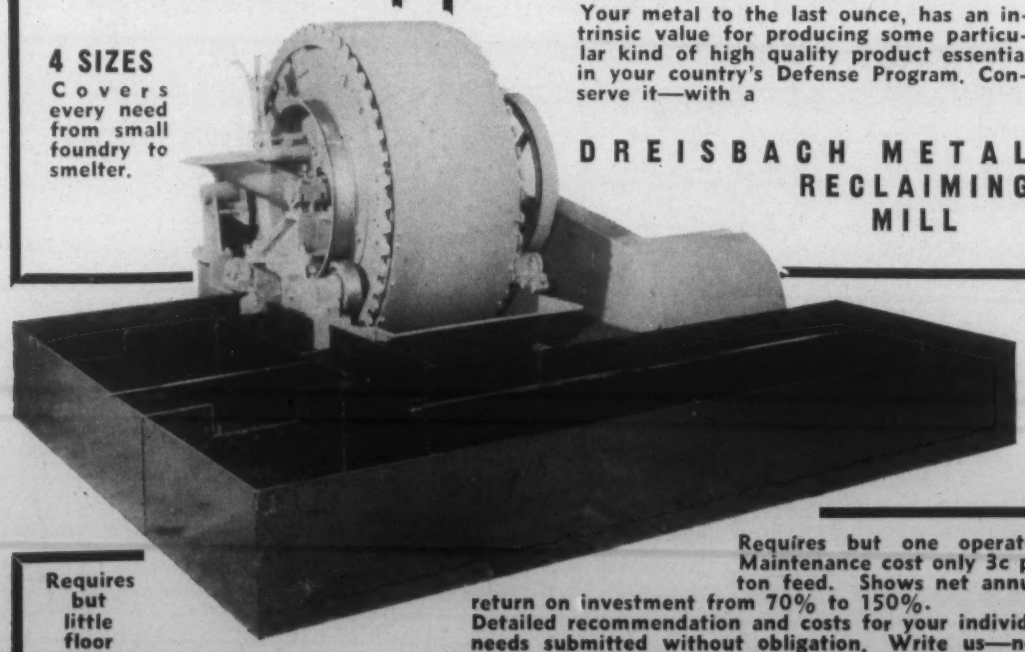
All metal from skimmings, slag, cinders and sweepings quickly reclaimed and ready for use without further treatment.

Mills and Concentrates Clean Metal in One Operation

Your metal to the last ounce, has an intrinsic value for producing some particular kind of high quality product essential in your country's Defense Program. Conserve it—with a

DREISBACH METAL RECLAIMING MILL

4 SIZES
Covers every need from small foundry to smelter.



Requires but little floor space.

Requires but one operator. Maintenance cost only 3c per ton feed. Shows net annual return on investment from 70% to 150%. Detailed recommendation and costs for your individual needs submitted without obligation. Write us—now.

DREISBACH ENGINEERING CORPORATION
527 Fifth Avenue, New York, N. Y.
45 Warburton Avenue, Yonkers, N. Y.

ability is essential. Kyle describes three methods for measuring flowability: (1) A hardness-gradient method of his own design; (2) a hardness differential method somewhat similar to the author's method, and (3) a sand-movement method as used by Dietert and Valtier.

The green-strength alone is unsatisfactory, and may be misleading, because high green-strength can be associated with a dry brittle sand, which is unfit for molding. The term molding signifies the need for plasticity, and it is this plasticity that is measured by the deformation determined in the deformation test.

The author's method for deformation determination employs a specially-made gage, constructed of light steel tube and disc ends. This turns out test-pieces weighing 135 g., *i.e.* not heavier than the A.F.A. test piece, which is about 170 g. The gage is carefully ground to 2,000 in. and kept in a small felt-lined box when not in use. This gage is used to calibrate the machine.

The test-piece is placed in the machine and the length measured with a light load of 1 lb. to ensure that all the backlash in the system is taken up. From this reading any variation from "true" is noted. The load is then applied steadily until the point of commencement of fracture, and the reading in pounds and fractions taken, as well as the micrometer reading.

Without moving the load screw, the compression plate of the machine is then depressed in order to allow the introduction of the 2,000-in. gage. This operation brings the pointer of the spring balance to a much higher reading, and, by rotating the load-screw carrying the micrometer, the pointer of the spring balance is returned to the exact reading of the maximum strength already noted.

The difference in these micrometer readings between the maximum compression reading on the deformed test-piece and the spring-balance reading when the 2,000-in. gage is substituted is the deformation, except for the necessary length correction (as the A.F.A. test-piece is of course, never exactly 2,000 in.). The preliminary length measurement furnishes by comparison with the 2,000 in. gage the correction to add or subtract. AIK .(1)

1a. Ferrous

Open Hearth Insulation

"Open Hearth Insulation." E. H. Younglove (Johns-Manville Co.) *Blast Furnace Steel Plant*, Vol. 29, Apr. 1941, Suppl. pp. 37-39. Practical.

In recent years it has become more common to insulate the various sections of the open hearth furnace itself, as well as the regenerators, slag pockets, fan-tails and flues, especially where forced-air draft is used. Insulation under the hearth and on the sloping backwall effects savings and protects the structural members supporting the furnace against overheating and possible buckling.

Insulation of regenerators has resulted in decreased fuel costs, increased speed of heats, less air leakage, high flue temperature to the waste heat boilers, and more satisfactory service in general.

In deciding about insulation of the roof, a number of factors must be considered, including the type of fuel, the height of the roof above the skewback, the roof thickness, the presence of automatic temperature control, the amount and type of scrap used, and the operators' skill. Insulated roofs require better control of combustion

conditions, resulting in better fuel practice and economy. Roof life is increased and fuel savings amount to 5-10%.

Proper application of insulation is very important. The entire base of a regenerator may be insulated with a minimum of 4 in. of coarsely ground insulating concrete, with Portland or Lumnite cement and water, tamped into place, and covered with 5 in. of fire-brick. On new steel-incased regenerators built with solid fire-brick walls not less than 13½ in. thick, all brickwork above the ground may be insulated with 4 in. of high-temperature block insulation or 4½ in. of insulating brick.

Blocks should be applied in 2 layers with all joints broken, closely butted, and pointed up with insulating cement. Brick should be laid up in a mortar of the same material with the thinnest possible rubbed joints. In either case, the thrust of the arches should not be carried on insulation. On existing regenerators, where brickwork is in good condition, the same insulation can be supplied.

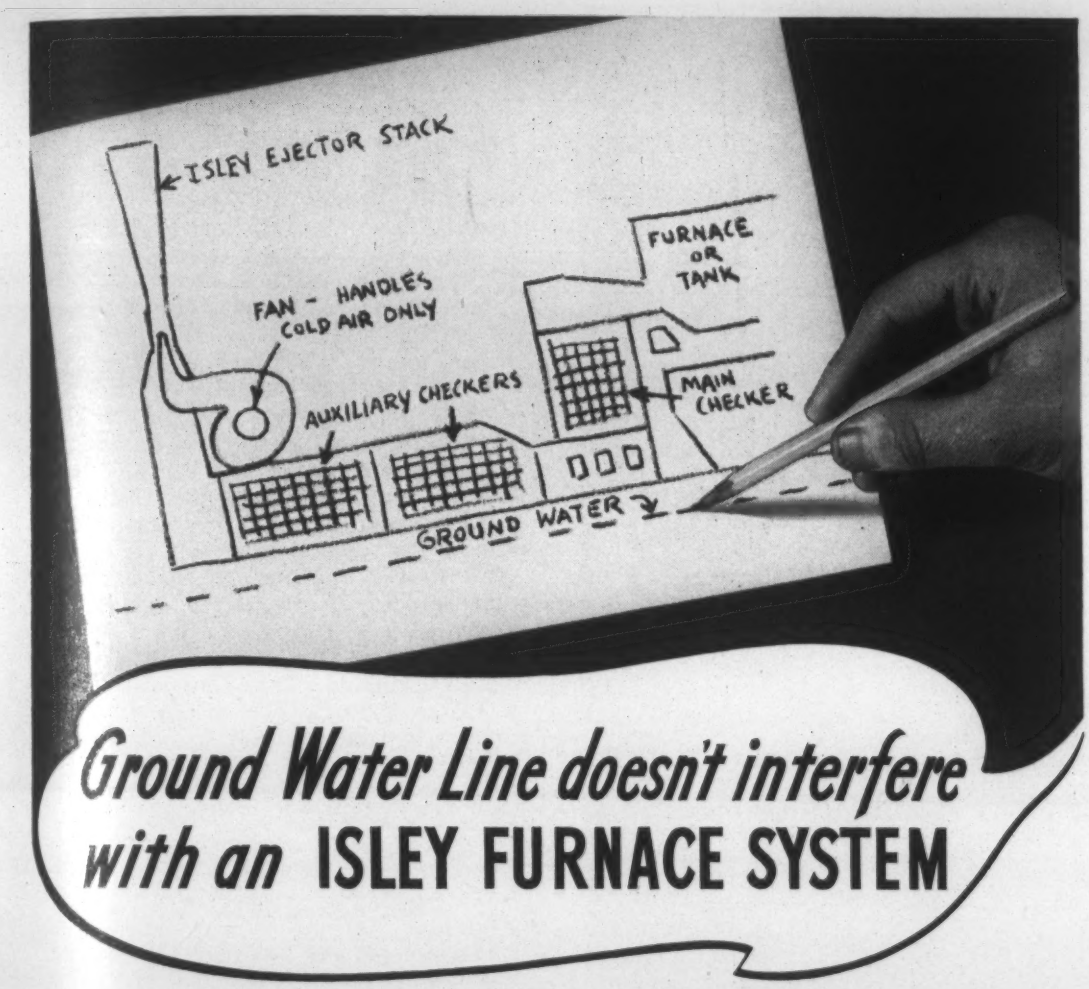
Bases of fan-tails, slag pockets, and flues may be insulated with a minimum of 4 in. of diatomaceous silica insulating concrete, tamped into place. Walls of fan-tails and slag pockets may be insulated with 4½ in. thick insulating brick, which is placed between the shell and the brickwork as the latter progresses, and is laid up with the thinnest possible rubbed joints.

On flue walls, 4½ in. of insulating concrete is placed outside the brickwork with the aid of forms. Fan-tail roof may be insulated with 2½ in. thickness of insulating brick or granular diatomaceous silica. The flue roof is insulated with 4 in. of insulating concrete at the same time as wall insulation is being applied.

The entire hearth and sloping backwall may be insulated with 5 in. of diatomaceous silica insulating concrete, placed in monolithic construction in the hearth pan, immediately above the supporting steel work, with proper provision for expansion. The usual hearth construction proceeds after the insulation has set. In some cases, 5 in. of insulating brick may be preferable. The walls above the charging floor may be insulated with 2 in. of vermiculite-base cement.

Among the materials successfully used for furnace roofs is a 2 in. layer of vermiculite-base cement. On a new silica-brick roof, the insulation should not be applied until the initial excessive expansion of the brick has taken place.

MS (1a)



Ground Water Line doesn't interfere with an **ISLEY FURNACE SYSTEM**

Don't let the ground water line interfere with your plans to increase the productive capacity of your present furnaces or soaking pits.

The Isley Regenerative Control System is being installed in many locations where a system operating with ordinary brick stack draft would be impracticable.

Forced draft with coordinated push and pull action, a feature of the Isley System, makes it possible to install additional regenerator checkers above the ground water line, often at locations away from the tank. Expensive foundation work and stack construction are not necessary.

Let us discuss the matter with you. If a system giving a uniform volume of combustion air at higher temperatures and capable of automatic control will increase production and lower costs, it's worth looking into—what?

MORGAN WORCESTER ENGINEERS AND MANUFACTURERS

MORGAN CONSTRUCTION CO., WORCESTER, MASS.
English Representative: International Construction Co.
56 Kingsway, W. C. 2, London, Eng.

V-31A

ISLEY Furnace Control System

Making High Speed Steel

"High Speed Steel." H. W. Pinder. *Iron Age,* Vol. 147, Mar. 27, 1941, pp. 39-43; Apr. 3, 1941, pp. 40-42. Descriptive of English practice.

After ascertaining that a given high speed steel will cast into sound ingots, the most important feature is to insure optimum ingot structure. Under normal conditions the high speed steel ingot is highly heterogeneous, even within the outer dendritic shell, while the heterogeneities are most severe along the axial zones.

The main consideration in producing high speed steel ingots of more uniform structure is reduction of the time between freezing of the outside and the center of the ingot. This factor is affected by: (1) casting temperature, (2) ingot mold design, and (3) cross-section of ingot. The first of these is the most difficult to control, but control has been made easier by the use of the Schofield-Grace quick-immersion pyrometer for measuring liquid steel temperatures.

With an increased nozzle size lower casting temperatures can be used. If the casting temperature is too low, and the rate at which the mold fills is slow, then gas is occluded in large amounts and unsound ingots result. Crucible high speed steel ingots can be cast at low temperatures because the rate of teeming from the pot can be very rapid.

As regards mold design, the thicker the walls of mold, the quicker will be the freezing rate across the section. The third factor (ingot-cross-section) is governed by the type of product, and wherever possible a minimum reduction in cross-sectional area of the original ingot of 96% should be arranged.

The Durville process (originally developed for non-ferrous alloys that gave rise to large numbers of surface seams when cast in the normal way) gives a more homogeneous ingot. Work at Woolwich gave interesting results with various steels. The process requires that the mold and ladle be fixed together so that the closed side is in a straight line. Thus, when the ladle and mold are turned through a 180° angle at a given speed, the mold fills quickly.

This allows the metal to be cast at low super-heat without turbulence. When casting high speed steel by the normal

method, a compromise must be made between too-high or too-low temperature. Casting at too-low temperature would result in an unsound ingot. At present, the largest ingot cast by the Durville process weighs 60 lbs. but larger ones could be cast.

To determine the effect of ingot size on carbide structure, 4, 6 and 8 in. ingots were produced from a ladle having a standard nozzle size and constant casting temperature, in 18-4-1 and 18-4-2 steel analyses. Sections examined from the outside to within the dendritic zones showed very little difference whether taken from the top, middle or bottom positions. The most striking differences were at the internal axial positions at the top and middle locations, the carbide envelopes were thicker in 6 and 8 in. ingots than in 4 in. ingots.

Forging causes the carbide envelopes to undergo distortion and local diffusion, which are facilitated by mechanical working and high temperature. This results in a redistribution of the carbides; at axial portions they appear as discontinuous bands, while within the dendritic zone the carbides are much more uniform and free from banding.

From all ingot sizes, the best carbide distribution was obtained in the bottom third. Given a normal discard, the next best position was the top third. The center third portion was the worst. Despite insufficient reduction area, the 4-in. square ingot had the best carbide distribution; there was little difference between the 6 in. and 8 in. ingots. Further reduction of 1¾ in. square cogged bars to 1 in. rounds established superior carbide distribution.

Special tools requiring the best distribution can be made from selected portions. It is now possible to make all high speed tools from 4 in. ingots, and by careful control of casting, improved structure can be had in larger-sized ingots.

VSP (1a)

CAN YOU DO THIS...
with the oxidizing agent in YOUR stainless steel pickling solution?
FERRISUL gives you safer, easier pickling of 18-8 stainless steel
A mild, acid oxidizing agent, Ferrisul (anhydrous ferric sulfate) will not burn the skin and does not give off dangerous or noxious fumes. A dry, free-flowing, granular powder, it solves many storage and handling problems created by other chemicals commonly used for pickling.
Equally important, recommended solutions of Ferrisul completely remove oxide scale from 18-8 stainless steel with no measurable attack on the alloy. Valuable metals, chromium and nickel, previously dissolved, and the chemicals consumed in their solution are now saved. The smoother surface which results, being free from pits or deep etch, means a better product after subsequent finishing operations.
Write today for the complete story on Ferrisul's unique advantages as they apply to your particular problems. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Mass.
LET'S GO! U.S.A. KEEP 'EM FLYING!
MONSANTO CHEMICALS
SERVING INDUSTRY...WHICH SERVES MANKIND

Thin-Wall Iron Castings

THIN-WALLED CAST IRON CASTINGS ("Gusseisen im Leichtbau") A. THUM, K. SIPP & O. PETRI. *Archiv Eisenhüttenw.*, Vol. 14, Jan. 1941, pp. 319-323. Practical.

Square box-castings with each of the 4 walls of different thickness (from 0.025 in. to 0.125 in.) were cast from irons of different compositions—containing from 3.2 to 3.6% C and from 1.4 to 2.5% Si. Tensile tests were then made of samples cut from each of the walls.

The harder pearlitic cast irons were found to be least sensitive to the effect of wall thickness, while the softer irons containing more ferrite were more sensitive. As the carbon and silicon content increased the effect of greater wall thickness in lowering the tensile strength became more pronounced.

With proper gating, the most suitable compositions for automotive cylinder iron in cylinders of 0.025 in. to 0.125 in. wall thickness, were those in which the sum of the carbon and silicon contents amounted to 4.8 to 5.3%. The effect of internal stresses in the castings on the tensile properties was eliminated by annealing at 1100° F. SE (1a)

Hot-Rolled Steel Strip

"IMPROVING THE QUALITY OF HOT ROLLED STRIP." PAUL J. MCKIM. *Steel*, Vol. 108, Apr. 28, 1941, pp. 74, 76, 78-79; May 5, 1941, pp. 66, 69, 72, 74. Practical.

The principal requirements of quality hot strip are a smooth and open surface, free from scale pits; uniform oxide or scale, free from redness or discoloration; uniformity of gage; good flatness; freedom from all mechanical defects; and physical properties and grain structure meeting specifications and performing successfully in fabrication.

Slab heating is the controlling factor in the manufacture of hot strip. The steel should be thoroughly soaked at a rolling temperature such that the mechanical working can be completed while the steel is still above the upper critical range. For low-carbon steels, this temperature is generally over 2200° F.

The furnace atmosphere is "controlled" to cover the slab completely with a scale that is readily cleaned and eliminated at the first high-pressure spray. To obtain the proper scale, the furnace atmosphere is usually maintained slightly reducing until shortly before discharging when it is slightly oxidizing.

Oxygenization is the most detrimental effect of heating. This causes cracked

edges due to "burning"; tight scale that is difficult to remove; and open surface. Resulting defects, in addition to cracked edges, are slivers, rolled-in scale, hairline seams, and poor gage, shape, physical properties, and grain structure.

Many defects originate in the strip mill. Guide rubs result from the strip's riding a guide and gathering scale or steel which is imbedded in the strip. Rough places on the guides cause guide scratches. Reel digs are usually caused by improper electrical and mechanical synchronization. "Snowballs" are caused by the tightening of one lap of strip over another.

While the chilled iron roll is the generally accepted work roll for hot strip mills and has served its purpose adequately, other types have been found superior in many respects. A steel roll cast with chill blocks in the mold is most successful. The steel work roll has not been successful beyond the No. 2 finishing stand. It improves the strip surface and increases the roll life per dressing. The generally accepted backup roll is a cast-steel mandrel with a forged alloy steel sleeve. MS (1a)

1b. Non-Ferrous

Magnesium Sand Castings

"Producing Sand Castings of Magnesium Alloys." M. E. Brooks & A. W. Winston (Dow Chemical Co.) *Foundry*, Vol. 69, Mar. 1941, pp. 34-37, 122-123; Apr. 1941, pp. 42-44, 108-112. Practical.

Sound foundry practice for magnesium alloys is similar in general principles to that used for other metals. However, because of the ease of oxidation at about 1125° F., high shrinkage, and low density of molten metal, there are numerous differences in detail.

Magnesium sand castings are made in green sand molds or, less commonly, in dry or baked sand molds. The sand may be natural or synthetic. Open sand is desirable because magnesium alloys are so light that an open sand permits the metal to flow into the mold cavities with little back pressure, and requires less tempering water and evolves less steam.

The average grain fineness is from 100 to 150 with A. F. A. permeability from 10 to 25. Clay content is 10-12%, which requires 6% water for tempering. Poor venting causes misruns, cold shuts and other defects.

The use of synthetic sand is increasing. It is made from a washed silica base with A. F. A. grain fineness of 65-100, mulled with 3% bentonite and about the same amount of water. Bank sands may be used if free from roots, coal, etc. The sand is conditioned after each use.

Considerable latitude exists in synthetic sands. In the authors' opinion, an intermediate sand of 80 grain size, 60-75 permeability, 4% bentonite, 3.8-4.2% water, and 6.5 lbs./in.^{2} compression strength is preferable for general use. It has proved satisfactory for castings up to 1000 lbs. and for sections up to 8 in. thick. Excessive bentonite causes stickiness.

All green sand should be chemically treated to inhibit the action of water vapor on the hot metal. A good inhibitor is a mixture of sulphuric acid, borax and sulphur. Four to 10% by weight is used, depending on the sand and section thickness.

Cores should be made from open sharp sand and provided with adequate vents. Core oils should form a minimum of gas. Core sand should also be treated with inhibitors to prevent burning of heavy metal sections. Two types of practice have been developed to obtain this protection: (1) lower percentages of sulphur and boric acid are mixed with the core sand; and (2) baked cores are sprayed with an aqueous solution of fluoride. Cores are soft and to facilitate pasting, joining surfaces are painted with a 1-3 shellac-alcohol solution to give stronger surface. The paste should not come through the core, with resultant danger of a blow.

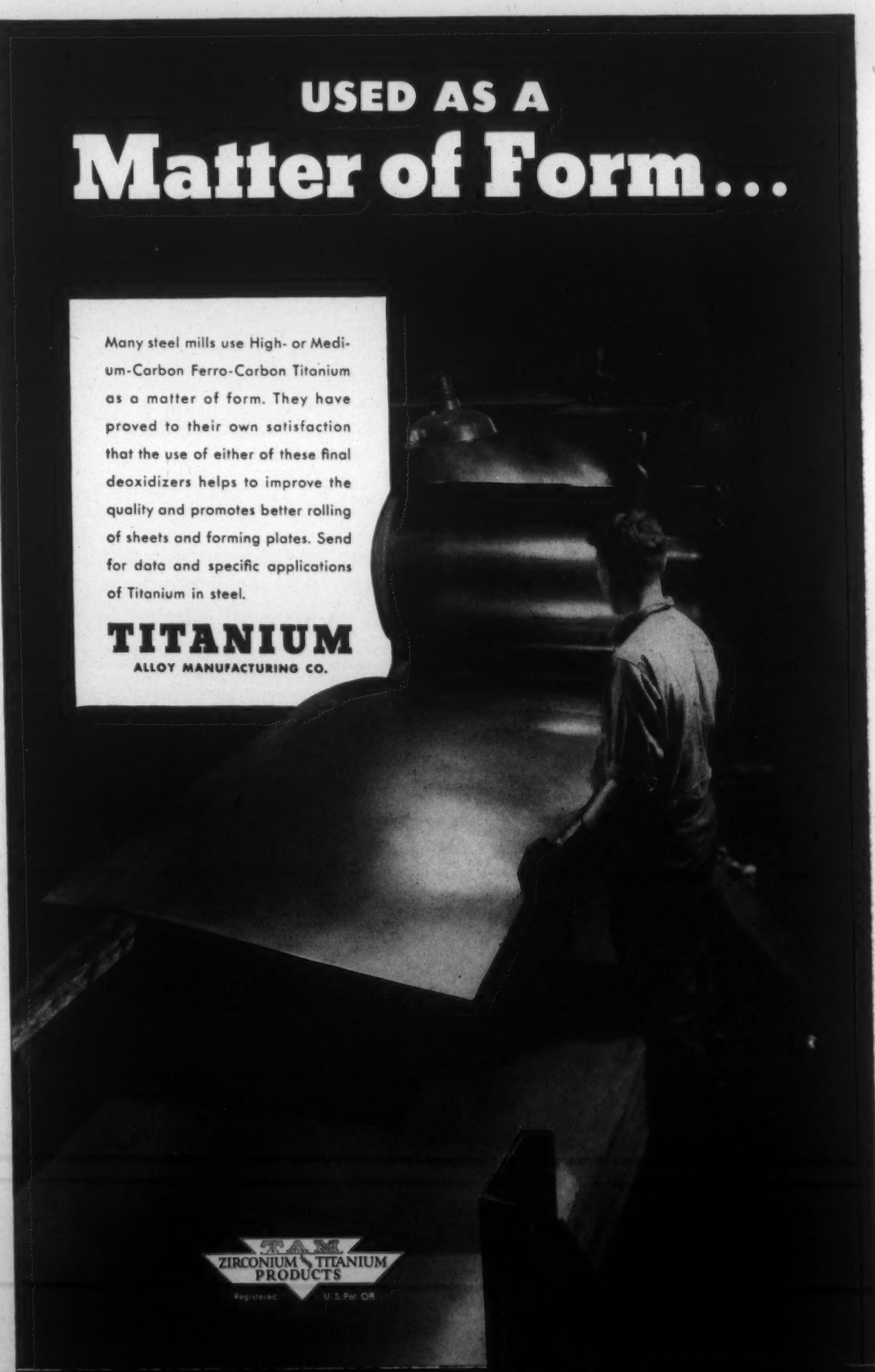
In molding magnesium alloy castings, the avoidance of turbulence is of vital importance. Therefore, the casting should be gated so that the metal is brought into the mold cavity at the lowest point and the gates are arranged so the sprue can be filled as quickly as possible after pouring starts. The use of a pouring basin and a filter placed at the bottom of the sprue are effective aids in keeping out oxide skin, and smoothing out the metal stream flowing into the mold.

The casting should be filled through several small gates because magnesium loses its heat very rapidly. A common type of gating is to place a ring runner completely around the casting with a number of small gates entering the casting uniformly around the circumference. Large

USED AS A
Matter of Form...

Many steel mills use High- or Medium-Carbon Ferro-Carbon Titanium as a matter of form. They have proved to their own satisfaction that the use of either of these final deoxidizers helps to improve the quality and promotes better rolling of sheets and forming plates. Send for data and specific applications of Titanium in steel.

TITANIUM
ALLOY MANUFACTURING CO.



GENERAL OFFICES AND WORKS: NIAGARA FALLS, N. Y., U. S. A.
EXECUTIVE OFFICES: 111 BROADWAY, NEW YORK CITY

Representatives for the Pacific Coast . . . . Balfour, Guthrie & Co., San Francisco, Los Angeles, Portland, Seattle, Tacoma
Representatives for Canada . . Railway & Power Eng. Corp., Ltd., Toronto, Montreal, Hamilton, Winnipeg, Vancouver, Sydney
Representatives for Europe . . . . . T. Rowlands & Co., Ltd., 23-27 Broomhall St., Sheffield, England

risers are used freely. Chills are used to equalize the freezing of heavy and light sections. Molds with chills are poured as soon as possible to avoid condensation on the chills.

Magnesium alloys for sand castings are melted in open-flux pot or crucible. The former method, now limited to small castings, uses 10-20% of the metal weight of fluid chloride-base flux. The crucibles employed are usually made of carbon steel of the firebox type, and are used without lining because iron is insoluble in molten magnesium. Furnace design and combustion control should be such as to minimize the scaling of crucibles. The most practical solution of the crucible-scaling problem is the use of carbon steel crucibles with the outer surface calorized or aluminum-sprayed, sealed, and annealed by the Metcoseal process or its equivalent.

In crucible melting, protection of the magnesium alloy is obtained by the use of flux (*e.g.* Dow flux No. 31). A sprinkle of flux is placed in crucible, which is then charged with ingot and scrap metal. As the metal is charged, and during melting the flux is dusted in to prevent burning. After melting (at a temperature not exceeding 1300° F.), the melt is stirred with an iron rod, while a fairly heavy coat of flux is added.

After the melt is stirred, the thermocouple is inserted and the melt is well covered with flux. It is then heated to 1600°-1650°F. and allowed to cool to casting temperature, between 1400° and 1500° F. (Super-heating refines the grain and improves the physical properties.) The metal burns at this temperature as soon as the flux is removed. Burning is controlled by a 50-50 mixture of finely-powdered sulphur and boric acid.

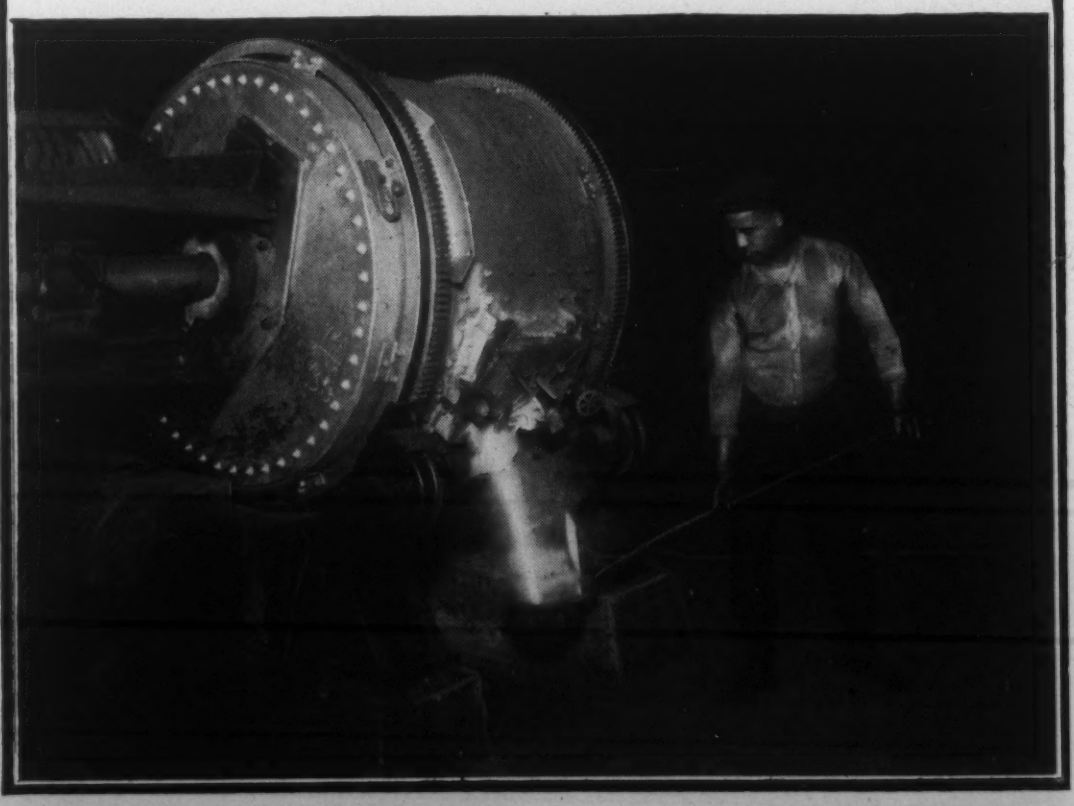
If proper casting practice has been followed, a layer of molten metal about 2-3 in. deep has been left in the bottom of the crucible. This is desirable because the danger of pouring the flux with the metal is much less if the crucible is not drained, and the liquid residue facilitates melting down of the next charge. Accurate melting and pouring temperature is secured by use of either chromel-alumel or iron-constantan thermocouples in mild steel protection tubes.

After cooling for a safe period following pouring, the castings are shaken out, and after sand blasting, the gates and risers are cut off. Heat treating is done before final cleaning operations. Circulating air, electric or gas fuel furnaces are used for heat treating. For temperatures up to 800° F., sulphur dioxide is a satisfactory inhibitor of surface oxidation, at concentrations of about 0.5%. VSP (1b)

8 WAYS YOU PROFIT WITH A DETROIT ROCKING ELECTRIC FURNACE

1—Faster Melting.
2—Lower Metal Losses.
3—Higher Average Quality of Product.
4—Less Machine Shop Scrap
5—Saving in Floor Space and Molding Equipment.
6—Use of Cheaper Raw Materials.
7—Less Labor.
8—Saving of Alloys.

These are but a few of the many advantages of this remarkable furnace. But don't take our word for these claims—find out for yourself. Let us arrange for you to see a few of these furnaces in operation and talk to their owners yourself. Get the low-down first hand from those who know. Write for further facts today.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY MICHIGAN

Rolling Magnesium

"Rolling of Magnesium." F. A. Fox. *Sheet Metal Inds.*, Vol. 15, Apr. 1941, pp. 490-491. Review.

Since magnesium has a close-packed hexagonal structure, slip at room temperature is confined to the basal planes 0001 with resultant limited ductility. However above a certain temperature (435° F. for pure magnesium), the pyramidal planes become operative, with increased ductility. Working should therefore be done above this temperature.

Moreover, rolling technique should be such as to avoid twinning—which seems to result from the application of compressive stresses as twins seriously reduce the mechanical properties. Magnesium crystals tend to orient themselves so that their basal planes lie in the direction of rolling; this leads to a marked anisotropy which shows up particularly in the mechanical properties which are higher in the transverse than in the longitudinal direction. Frequent cross rolling and reheating will lead to the greatest uniformity of properties.

If the rolling temperature is too *high*, excessive grain size will result, and will lead to undesirably low mechanical properties and possibly even cracking during rolling. *Low* rolling temperatures also produce surface cracking; therefore rolling temperature must be carefully controlled and the rolls themselves should be well heated.

Rolling speeds as high as 150 ft./min. can be used, but the speed should not be excessive since if the rate of working is much in excess of the rate of annealing (which takes place at the working temperature), cracking is likely to occur. JZB (1b)

Processing and Fabrication

FORGING, FORMING, MACHINING HEAT TREATMENT, WELDING, FINISHING

Drop and Hammer Forging, Drawing, Extruding, Stamping and Machining. Age-Hardening, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Surface-Hardening and Tempering. Heating Furnaces, Refractories, Fuels and Auxiliaries. Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting, Cleaning, Pickling, Electroplating, Galvanizing, Metallizing, Coloring and Non-Metallic Finishing.

Hard Chromium Plating

"Plating for Life—Not Looks." R. F. Yates. *Am. Machinist,* Vol. 85, Apr. 16, 1941, pp. 327-330; Apr. 30, 1941, pp. 381-383; May 14, 1941, pp. 426-428. Practical.

Hard chromium plating is valuable in hard-surfacing tools and dies as well as in salvaging worn tools. No nickel-base deposit is required, and the chromium plate is usually 0.0005 in. or thicker.

Chromium has long been used for reclaiming worn plug gages; undersize gages are plated until they are oversize, and then are ground to the desired size. Likewise, steel molds for plastics are subject to etching in service, which, unless the die is polished frequently, becomes so marked that the molded articles lack lustre. A chromium flash will preserve the polish of a die for a month, while 0.001 in. of chromium will usually last for the lifetime of the die without intermediate polishing.

Chromium plating of draw dies not only increases their life, but also reduces or even eliminates scoring. Since chromium has no affinity for solder, it is useful on soldering jigs. The wear may be drastically reduced; for example, a steel plug gage lasted for 9970 checks without chromium plating, but for almost 49,000 checks after chromium plating.

Hard chromium plating (up to 0.016 in.) of heavy steel rolls used in paper making is an established procedure. Such chromium-plated articles take a very fine finish on lapping. Hard chromium plating is not limited to steel, but has also been used on brass, copper, aluminum and duralumin.

Procedure

Hard chromium plating requires a different technique from that used for decorative plating. A good solution for hard chromium is: 300 g./l. chromic acid, 4.1-4.4 g./l. sulphuric acid, at 130°-140° F. The chromic acid should not fall below 285 g./l., as otherwise burning or peeling will immediately develop.

Careful pre-cleaning is essential. The customary pickle is 50° Bé. sulphuric acid; the pickling is done electrolytically with lead cathodes and a current density of 50 amps./ft.^{2} Not-heat-treated steels require about 5 min., while heat-treated steels must be pickled for 8-10 min.

The article is then hung in the chromium bath until it has attained the temperature of the bath. It should then be connected as the anode for 15-20 sec.; this reverse current should not be less than 300 amps./ft.^{2} for plain steel, with about 4-5 volts. The polarity is then reversed for the actual plating.

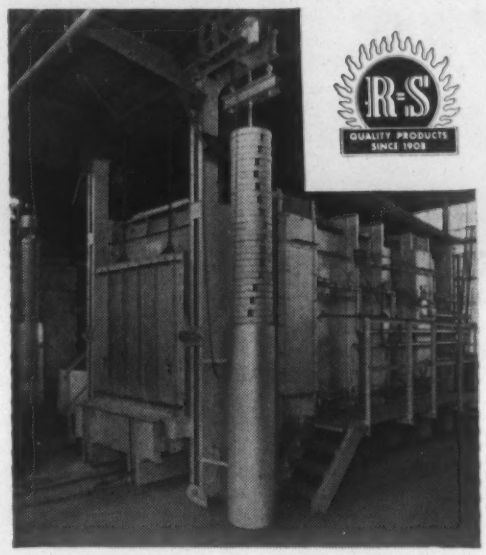
If the article has not previously been chromium-plated, the operation is started at 300 amps. and then increased to 600 at the end of an hour. If the article has had a previous chromium plate, the reverse current should be 200 amps./ft.^{2}; while the plating should be started with just enough current to cause a slight deposit. The current is then raised each 20 min. until it reaches 300 amps./ft.^{2}, at which value it is allowed to remain for 1 hr. The current then may be increased to 600 or 800 amps./ft.^{2} for the rest of the plating.

Plane or flat surfaces should not be plated faster than 0.001 in./hr. The distance between the lead anode and the cathode should be about ¼ in. for steel, but only 1/16 for cast iron. The plating solutions have very low throwing power, so odd-shaped pieces require special-shaped anodes.

A stripping tank is practically standard equipment, as failures are occasionally encountered. One strip commonly used is a strong solution of soda ash, sodium bicarbonate, or lye (15 oz./gal.); a reverse current with 50 amps./ft.^{2} and steel cathodes should be used. Cooling is necessary to keep the temperature down. This solution will not attack the base.

If a previously chromium-plated article is being re-built, it must not be stripped if the surface is still completely covered with chromium. Hard chromium can be ground best with a softer, more freely cutting wheel than is used for hardened

NOT 1 BUT 4



An R-S customer's* initial purchase was so satisfactory that three more five-ton units were installed. Propane-fired for hardening, normalizing, annealing, stress relieving and tempering processes. To assure best metallurgical results the cars were equipped with individual electric motor drives—an exclusive R-S design.

33 years' experience in designing all types of industrial furnaces. Call on *experienced* R-S Engineers.

* *Name on request.*

When you see a butterfly, think of R-S Butterfly Valves.

•

Positive control with economy of air, gas, steam and liquids.

R-S PRODUCTS CORPORATION
4522 Germantown Ave. Philadelphia, Pa.

R-S CAR HEARTH FURNACES

HEAT TREATING

..Rods
..Slabs
..Sheets

It's a curious thing that one of the most important factors in making steel by the millions of tons costs near to nothing and gives the operators the least trouble.

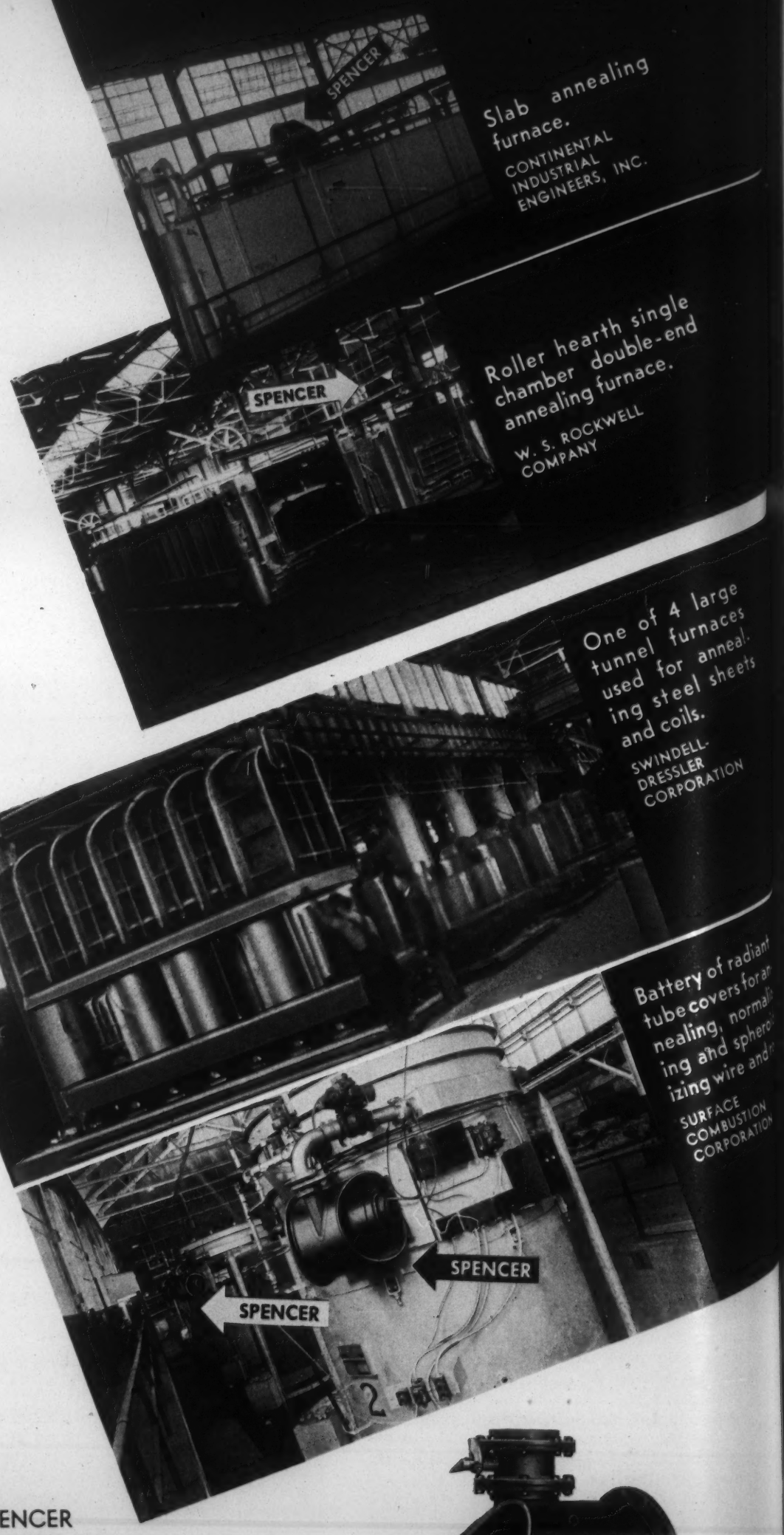
Air is free, so they say, but it takes tons of air to heat treat tons of steel.

Temperatures must be precise and uniform, length-wise as well as cross-wise, in each zone, regardless of the size of the furnace. The air must not stop or hesitate, and air surges may easily be fatal to tons of work.

That's the steel business, and that's the condition under which Spencer Turbo-Compressors have obtained their greatest measure of recognition during the past quarter century.

The progress in the design of furnaces for tonnage steel heat treating has been phenomenal. Only a few of the smaller types are shown on this page.

Your furnace manufacturer will give you complete information on Spencer equipped furnaces.



Slab annealing furnace.
CONTINENTAL INDUSTRIAL ENGINEERS, INC.

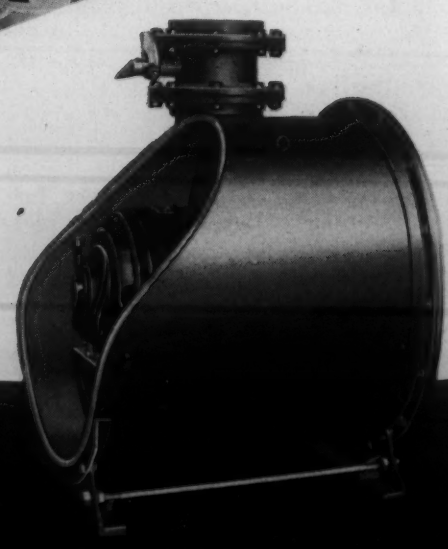
Roller hearth single chamber double-end annealing furnace.
W. S. ROCKWELL COMPANY

One of 4 large tunnel furnaces used for anneal. ing steel sheets and coils.
SWINDELL-DRESSLER CORPORATION

Battery of radiant tube covers for an nealing, normali ing and spheroi izing wire and r
SURFACE COMBUSTION CORPORATION

THE SPENCER DATA BOOK ON AIR SERVICE WILL BE SENT ON REQUEST

S-209-C



FOR
Agitation
Combustion
Exhaustion
Gas Boosters
Ventilation & Cooling
Airplane Testing

SPENCER
HARTFORD
Turbo Compressors

35 to 20,000 cu. ft.
1/3 to 300 H.P.
8 oz. to 5 lbs.

THE SPENCER TURBINE COMPANY • HARTFORD, CONNECTICUT

tool steel. Aluminum oxide wheels with 80-100 grits are satisfactory.

Bath Control

Aside from temperature control, hard chromium bath testing may be divided into 3 classes. First, chromic acid content must be controlled. If the chromic acid drops below 38 oz./gal., the plate has a tendency to burn and peel. Determination of specific gravity by means of a Baumé hydrometer is accurate enough to test the chromic acid content. Tables are available [one is given in the original article] to correlate Bé. with chromic acid content. Addition of the required chromic acid in the form of crystals is not satisfactory; the best way is to dissolve the chromic acid in hot water before addition.

Also of importance is control of sulphate content. In hard chromium plating, a sulphate ratio 73:1 is usually used, although in decorative chromium plating this ratio may be as high as 100:1. This ratio is quite critical, and the throwing power, at best low, is made still worse unless the sulphate regulation is good. Low sulphate ratio can be cured by additions of sulphuric acid; high ratios by the addition of barium carbonate to the bath.

Trivalent chromium content is the third factor to be controlled. Excessive trivalent chromium narrows the bright plating range of the solution and seriously increases its resistance; it also decreases the throwing power. A simple kit can be obtained for quick determination of trivalent chromium by means of a colorimetric determination.

Excessive trivalent chromium can be removed by hanging iron anodes in the bath in the center of porous clay pots when the bath is not in use. Operation of the bath over night with this iron anode will oxidize the trivalent chromium to chromic acid. JZB (2)

Making Flexible Metal Tubing

"Flexible Metal Tubing." R. J. Metzler (Bendix Aviation Corp.) *Iron Age*, Vol. 147, Apr. 24, 1941, pp. 46-49. Descriptive.

Flexible metal hose is produced from 6 non-ferrous and 2 ferrous alloys. They include 3% Si bronzes, 85-15 brass, 70-30 and 80-20 cupro-nickel, pure silver, Monel metal, aluminum, nickel, stainless steel and low-carbon steel. Seamless tubing ranges in size from $\frac{1}{8}$ in. to $2\frac{1}{2}$ in. inside diameter.

For high strength and medium flexibility a close-pitch hose is used. For high flexibility and average strength, a normal-pitch hose is specified. Rigid specifications cover chemical composition, size tolerances, surface finish and definite grain size.

The raw tubing is drawn cold, in one pass, to about $\frac{1}{3}$ of its original wall thickness and $\frac{3}{4}$ of its original diameter. Drawing is done on a draw bench with rotating steel balls in the die head and a beveled type of mandrel. A water-soluble drawing compound gives the best results.

To prepare the tube for corrugating, a recrystallizing anneal is necessary. This is done in a bright annealing conveyor furnace. Each length of tubing must be annealed to remove the scale to the next operation. Atmospheres used are made by cracking city gas with air.

The corrugating operation is entirely automatic. In properly annealed tubing the operation is readily performed and only a small amount of cold-work stress is introduced. This stress is subsequently relieved by a low temperature anneal.

There is no change in grain size in corrugating. Grain size affects corrugating only from the standpoint of the hardness of the metal. The grain size of most ma-

For Better Rivets!

a. c. f.

BERWICK

3-Electrode

ELECTRIC RIVET HEATER

Saves 50 to 70% in Heating Cost

No. 3, for heating rivets 5/8, 3/4, 7/8 and 1" diameter, from 1 to 7 3/4" long, or longer if desired.
No. 4, for heating rivets from 3/4 to 1 3/4" in diameter, from 1 to 9" long, or 12" long, if desired.

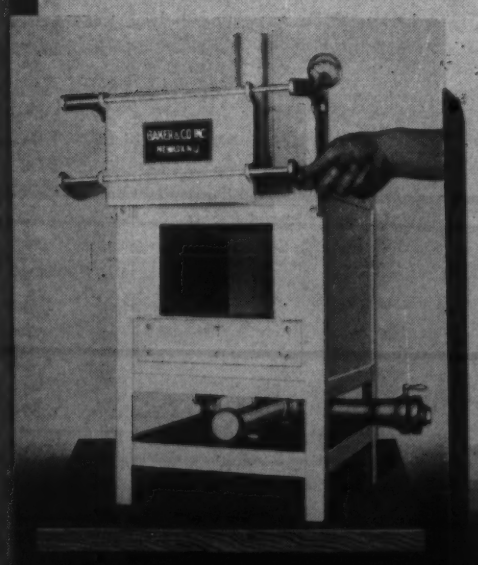
This is but one of a wide variety of Berwick Electric Metal Heaters, all of which offer many important advantages and economies. Write for descriptive literature.

BETTER RIVETS AT LOWER COST. No waiting time; throw the switch, the work starts heating. Reaches full heat in a matter of seconds. Every BTU in a KWH goes into the work. Pull the switch; expense stops. Eliminates intense heat, noise, smoke, odor. No early morning overtime in lighting the furnace. Far better working conditions.

AMERICAN CAR AND FOUNDRY COMPANY
30 CHURCH STREET, NEW YORK, N. Y.
CHICAGO DETROIT ST. LOUIS

1850° to 2450°F Without Blower or Compressed Air

BAKER small gas fired furnaces prove that high temperatures can be obtained without blower or compressed air. Noiseless. Easy to install. Economical. There are Baker furnaces for tool rooms, for treatment of high speed steel and a hydrogen furnace for bright annealing, brazing and soldering without flux. Send for catalogue.



BAKER & CO., INC.
113 Astor St., Newark, N. J.

New York San Francisco Chicago

terials may be as low as 0.025 mm. minimum. For Monel, nickel, stainless steel and similar high-work-hardening alloys, the grain size must be kept above 0.045 mm.

If the metal is too hard, the fingers on the corrugating machine will not complete the operation. Corrugated material is washed in a rotary washer. Special stress-relief annealing is given to flexible hose to dampen vibrations in service. VSP (2)

Cemented Carbide Tool Edges

THE TOOL EDGE FOR PRECISION MACHINING ("Die Werkseugschneide beim Feinstbearbeiten") K. KRESS. *Maschinenbau-Betrieb,* Vol. 20, Feb 1941, pp. 59-61. Review.

Since sintered carbides are unhomogeneous materials, there is always some roughness no matter how carefully carbide tools are ground. The machined surface, therefore, shows roughness beside the usual feed grooves. This causes the silky sheen on metals machined with carbide tools.

Roughness is also detrimental to the running of the chips and causes built-up edges. Great wear caused by the machining of steel and cast iron progressively changes the cutting conditions. Worn edges cause radial pressure and vibration on the work or the tool holder.

Those cutting angles that give the best results as to efficiency and surface may cause rapid wear. The adjustment of the secondary cutting edge is of particular importance for surface smoothness. Under an angle of 4° and with a point of 0.004 in. the roughness of the machined surface is only 2μ.

Diamond bits are usually applied for non-ferrous alloys only. The adjustment is not critical as far as wear is concerned and can be so held that best cutting efficiency and surface smoothness are obtained. Finest finish can be produced with the secondary cutting edge at an angle less than 5 min. RPS (2)

Underwater Cutting and Welding

THE MOST COMMONLY USED UNDERWATER CUTTING AND WELDING METHODS AND THEIR PRACTICAL APPLICATION ("Die gebräuchlichsten Unterwasser-Schneid- und Schweissverfahren und ihre praktische Anwendung") L. TETZLAFF. *Techn. Zentralblatt prakt. Metallbearbeitung,* Vol. 51, Jan. 1941, pp. 43-44; Feb. 1941, pp. 125-128; Mar. 1941, pp. 187-190. Practical.

The present state of underwater cutting and welding is reviewed and practical experience with the operation in a leading German shipyard is reported. Attention is directed to the great variety of jobs, the number of which has increased several times during this war.

The 3 principal methods discussed at great length are as follows: (a) oxygen + gas (acetylene or hydrogen) cutting, (b) oxygen + liquid (benzine) cutting, and (c) electric cutting and welding. The author is obviously in favor of the last method, although it is "still in its infancy," but has a "great future."

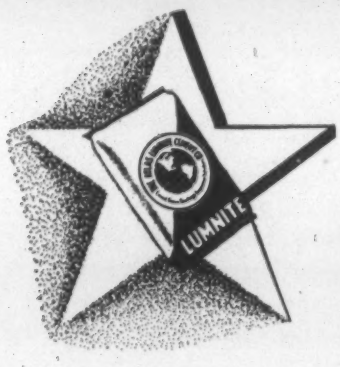
Ignition with method (a) is done electrically and with (b) by match above water. The flame is not extinguished on submersion in either case. With method (c) the arc starts by contacting the object to be cut or welded. The cutting speed of method (a) is lower than that of (b); with the latter, speeds of 20-25 in./min. and 6-7 in./min., respectively, for 0.4 in. and 4 in. plates have been obtained. By pressing the tip against the work, increased cutting speeds can be realized. Owing to lack of preheating, method (c) is slower, about 6 in./min. for 0.4 in. plates.

Only method (c) is suitable for welding. The replacement of electrodes is performed under water. Welding speed is about 2.3 in./min. for 0.4 in. plate provided with a vertical V-joint.

In general, the temperatures of (a), (b) and (c) are 4500° F., 5600° F. and 6500° F., respectively. As to danger of explosion, 57% of all possible gas mixtures are explosive with (a) and 4% for (b). Of course, the explosion hazard with (c) is absent.

The gas combustion in liters/cm.^{2} cutting area is 5-6 acetylene + 36-45 oxygen or 24-30 hydrogen + 36-45 oxygen for method (a) and 25-40 oxygen + 0.015-0.020 benzine for method (b). As to method (c), 0.03-0.05 kw.-hr./cm.^{2} area is needed for cutting and 0.1-0.15 kw.-hr./cm.^{2} for welding.

For the same job, about 20-25 times as much weight in equipment has to be transported for (a) as compared with (b). The welding and cutting outfit for (c) is much lighter than either (a) or (b), even when a Diesel engine is employed. The hazards involved in using method (a) or (b), particularly on board warships, is non-existent with (c). Only equipment for method (c) can be used for both underwater cutting and welding. The electrodes used are water-proof and the diver's helmet is insulated. EF (2)



AVOID DELAY IN FURNACE CONSTRUCTION

Use Refractory Concrete!

...It is available and adaptable

YOU can get the materials for Refractory Concrete and Refractory *Insulating* Concrete *now*—or whenever you want them. Refractory Concrete is made with LUMNITE as the binder for refractory aggregates. LUMNITE is sold by building supply dealers throughout the United States and in Canada. Aggregates *can be easily obtained or prepared in your plant.*

Added to availability is the adaptability of Refractory Concrete and Refractory *Insulating* Concrete. *This also eliminates delay.* Cast-in-place Refractory Concrete is formed to fit the job. Any thickness or shape of wall or arch can be placed without limitation by the size of masonry units, without cutting, and without waiting for special shapes.

High cold-strength speeds up the construction schedule. Refractory Concrete is ready for service in short order, usually before installation of burners and accessories is completed. *You do not have to wait for Refractory Concrete.*

Pre-cast units of Refractory Concrete can be made in your plant, ready for installation as needed. Special shapes, made in any form desired, can be stored or installed the day after molding—without pre-firing.

Let us tell you where you can get LUMNITE and aggregates for Refractory Concrete and Refractory *Insulating* Concrete. Write Atlas LUMNITE Cement Co. (United States Steel Corp. Subsidiary), Dept. M - 9, Chrysler Building, New York City.

Keep LUMNITE Castables in Stock—
if you prefer a factory-prepared mixture. Made with LUMNITE and selected aggregates, these castables are ready for use upon mixing with water. With LUMNITE castables you can have Refractory Concrete or Refractory Insulating Concrete in minimum time. LUMNITE Castables are obtainable from refractory manufacturers and distributors in all parts of the United States and Canada.

▶ Specify Castables "Made with LUMNITE" ◀

LUMNITE FOR REFRACTORY CONCRETE

PUT YOUR LIBRARY IN READINESS FOR ACTIVE SERVICE NOW!

PROTECTIVE COATINGS FOR METALS

by R. M. BURNS, Ph.D.

Assistant Chemical Director, Bell Telephone Laboratories

and A. E. SCHUH, *Ph.D.*

Director of Research, United State Pipe and Foundry Company

Great advances have been made during the last decade in the technique of protecting metals from corrosion by coating them either with other metals, or with paint, lacquer or enamel. The advances in the technology of organic finishes have been particularly significant.

This Up-to-the-Minute Volume is the only book covering all types of protective coatings for metals, including paints, lacquers and enamels; gives the latest information on the theoretical aspects of corrosion; suggests ways of diagnosing failure due to corrosion; covers newest achievements in plating technique, "bright" nickel, "bright" zinc, electroplated tin, and continuous electroplating of steel strip; discusses in great detail all the important methods of applying protective coatings, hot-dipping, metal-cladding, electroplating and sherardizing; considers and evaluates all metals commercially used for purposes of protection; describes approved methods of testing metal and paint coatings by exposure to varied atmospheric and soil environments, together with results of numerous tests recently completed; correlates for the first time the work of the paint technologist and the corrosion expert; tells how protection may be provided for a wide variety of industrial products such as automobiles (body and trimmings), airplanes, air-conditioning equipment, structural steel, underground pipe lines, wire, food containers, beer cans, steel sheet, tank cars and telephone apparatus; critically discusses the composition and properties of paints, lacquers, and enamels, with particular emphasis on synthetic resin vehicles; includes references to the work of several hundred authors. Table of contents is too long to give here. It will be supplied on request.

A C. S. Monograph. 407 pages, 89 figures. $6.50

A TEXTBOOK OF METALLOGRAPHY

Chemistry and Physics of the Metals and Their Alloys

by GUSTAV TAMMANN

Director, The Institute for Physical Chemistry, Göttingen

Translated from the Third German Edition by

R. S. DEAN and L. G. SWENSON

CONTENTS: Introduction. One-Component Systems; The Process of Crystallization. The change of Properties with Change of State. The Changes of Properties by Working of Metals. Binary Systems: The Equilibrium Diagram. The Surfaces of Heat Content of Binary Mixtures. Thermal Analysis. Reactions in the Solid State. The Relation of Metals in Binary Mixtures. The Equilibrium Diagrams of Special Binary Systems. The Physical Properties of Binary Alloys. The Chemical and Electrochemical Properties of Binary Alloys. Three-Component Systems. Index of Metal Pairs Whose Equilibrium Diagram is Known. Index.

388 pages, 248 figures.....$7.00

TITANIUM, WITH SPECIAL REFERENCE TO THE ANALYSIS OF TITANIFEROUS SUBSTANCES

by WILLIAM M. THORNTON, JR.

Associate in Chemistry, Johns Hopkins University

CONTENTS: The Discovery of Titanium. The Occurrence of Titanium in Nature. The General Chemistry of Titanium. The Industrial Applications of Titanium and its Compounds. The Detection of Titanium in the Qualitative Analytical Course, Gravimetric Methods. Colorimetric Methods. Oxidimetric Methods. The Analysis of Titaniferous Materials. The Preparation of Certain Reagents. Notes and References. Index.

A C. S. Monograph. 262 pages, 26 figures. $3.75

SHEET STEEL AND TIN PLATE

by R. W. SHANNON

CONTENTS: Part I: Industrial Iron Products in General. Introduction. The Different Kinds of Iron Products. Part 2: Sheet Steel and Tin Plate. Definitions, Annual Production in the United States, Types of Steel Used, The Principles of Rolling Sheet Steel Products. Continuous Hot-Rolling of Sheets. The Sheet Steel Makers' Contribution to Industry. Tables Pertaining to Sheet Steel Products. The Shaping Process: Hot-Rolling and Shearing. The Refining Process: Annealing. The Refining Process: Pickling. The Refining Process: Cold-Rolling. The Refining Process: Resquaring; Flattening Operations; Oiling. Protective Coatings. The Refining Process: Metallic Coating Processes. Inspection; Forming and Painting; Preparation for Shipment. The application and use of Sheet Steel and Tin Plate (with Brief Descriptions) of Principal Grades and Finishes. Appendix "A." The Nature and Effects of the Annealing of Sheet Steel. Appendix "B". Definitions of the Terms Used Herein for Describing the Texture of Sheet Steel Surfaces. Appendix "C." Definitions of Terms Relating to the Physical Properties of Sheet Steel. Appendix "D." Abbreviations for Treatments, Finishes and Quality of Sheet Mill and Tin Mill Products. Appendix "E." How to Specify Sheet Steel Products. Appendix "F." Tolerances, or Standard Permissible Variations of Sheets in Gage Weight, Gage Thickness, Size and Flatness, Adopted by the Association of American Steel Manufacturers, March 28, 1929. Appendix "G." Notes. Bibliography. Index.

285 pages, 69 figures.....$5.00

BEARING METALS AND BEARINGS

by W. M. CORSE

Consulting Metallurgical Engineer, Secretary Institute of Metals Division, American Institute of Mining and Metallurgical Engineers

CONTENTS: History—Early Developments. Bearing Metals. History of Development of Bearing Metals. Types of Bearing Metals. White Metals. Bronzes. Graphite Bearing Metals. Types of Bearings. Factors Deciding Choice of Type. Bearing Design. Bearing Troubles and Failures. Testing Bearing Metals and Bearings. Lubrication. Effect of Bearing Metal on Lubricants. Bibliography—Literature References from 1900 to 1928 inclusive —Bearing Metals—General Papers. Mechanical Properties. Description and Properties of Alloys Suitable for Bearing Metals. Structure and Constitution. Mechanical Testing. Physical Properties. Effect of Various Factors on Structure and Properties. Chemical and Physico-chemical Properties of Bearing Metals and their Components. Manufacture. Bearings—General Papers on Bearings and Lubrication. Descriptions. Bearing Design. Bearing Troubles and Failures. Friction and Lubrication. Empirical Laws of Friction. Theory of Lubrication. Lubricants. Lubrication of Bearings. Testing Lubricants and Bearings. Abstracts of Selected Papers. Tables Showing Properties of Bearing Metals. Index.

A C. S. Monograph. 383 pages, 7 figures. $5.25

ARSENICAL AND ARGENTIFEROUS COPPER

by J. L. GREGG

Metallurgist, Battelle Memorial Institute

CONTENTS: Historical and General. Properties and Use of Copper. Arsenical and Argentiferous Copper. Constitution of Arsenical and Argentiferous Copper. Electrical and Thermal Properties of Arsenical and Argentiferous Copper. Mechanical Properties of Arsenical and Argentiferous Copper and Copper Alloys. Corrosion of Arsenical Copper and Brass. Uses of Arsenical and Argentiferous Copper. Appendix. Bibliography. Index.

A C. S. Monograph. 189 pages, 56 figures. $4.00

REINHOLD PUBLISHING CORP. 330 WEST 42 STREET, NEW YORK, U.S.A.

2a. Ferrous

Dross in Hot-Galvanizing

"Relation of Galvanizing Bath Temperature to Iron Content of Dross." Wallace G. Imhoff. *Products Finishing,* Vol. 5, May 1941, pp. 24-36. Practical.

Dross formation in the galvanizing pot increases with bath temperature. The increased dross takes up more iron, thereby requiring higher temperatures to keep the bath molten with a consequent further pick-up of iron. This pyramiding of effects is the basis for the assertion that "dross makes dross."

Zinc dross consists of zinc-iron crystals that mechanically trap large amounts of molten zinc when the dross is removed from the bath. The best way to separate the zinc from the dross is by attaching a vibrator to the dross spoon. From 15 to 20% more good zinc is recovered this way than by the old hand method of cutting and slicing with a shovel to let the zinc run out.

The iron content of the dross increases slowly up to 1650° F., and much more rapidly thereafter. Below 1650° F. the zinc-iron alloy forms long slender crystals of the rhombohedral type in the hexagonal system. Above 1650° F. the crystals change to a hexagonal pyramid form of the first order, and dissolve more iron. When these crystals are again cooled below 1650° F. this extra iron is available to react with zinc and form more dross.

On the basis of these facts it is recommended that the dross should not be sweated at high temperature to recover zinc since this zinc will be high in iron, and will tend to produce more dross when used again. Drossing of a galvanizing bath should take place at the same temperature at which the bath is normally operated. Temperature control of the bath is important; it should never go above 1650° F.

Dross is heavier than the zinc and sinks to the bottom of the pot. Therefore heating the bottom of the pot should be avoided as this will tend to cause the dross to float and interfere with the galvanizing operation. PCR (2a)

Hardening High Speed Steels

Increased Heat Treating Requirements of Modern High Speed Steels ("Die erhöhten Ansprüche der neuen Schnellstähle an die Wärmebehandlung") Vits. *Automobiltech. Z.,* Vol. 44, Feb. 1941, pp. 92-94. Practical.

Lower alloy "high speed" steels yield excellent results if the heat treatment is closely controlled. It is recommended to preheat the high-speed steel to 1650°F.; for large pieces a second preheating step to 2000°F. is advantageous. This prepares the solution of the carbides, but it should not be extended too long. In the hardening furnace these steels should remain at the maximum temperature just long enough to heat through.

Water as a quenching medium if allowed to heat to 140°F. has a quenching power substantially less than that at 70°F. The maximum rate drops below the 700°F./sec. point which is too low considering the critical cooling rates of high speed steels. The maximum cooling rate of oils is 350°-550°F./sec., while that of water is 1100°F./sec.

The quench of oils is improved by heating the baths. Beet oil quenches more drastically than mineral oil.

The gap between water and oil quenching media is filled by solutions of the ratio SiO_2: $Na_2O = 3.78$ (SiO_2 concentration varying from 1.7 to 20%). Solutions of glycerine in water are in this class also, but dangers are involved in handling them. RPS (2a)

Processing High-Explosive Shell

"Composition, Metallurgy and Other Considerations Influencing the Manufacture of High-Explosive Shell." Arthur F. Macconochie (Univ. Va.) *Steel,* Feb. 3, 1941, pp. 54-56, 58, 60. Descriptive.

Open-hearth and electric-furnace steels are used in the U. S. for armor-piercing shell. Ingots are cast nose down in a chill to prevent piping and segregation. These projectiles frequently contain about 0.35% C, 4 Ni and 2 Cr.

The point of an armor-piercing projectile should be as hard and shock resistant as possible, but the body must be tough and strong. Heating for hardening is begun at the point, usually in a lead bath, followed by a complete quench in an agitated bath of cold water. The base of the shell is heated to a somewhat lower temperature than that used for the quench and is suspended nose down up to the bourrelet in agitated cold water. Any sharp line of structural change between the exceedingly hard nose and the tougher and more resilient rear of the shell must be avoided.

The finish-turning operation is accomplished between grain refinement and hard-

The FIRST CUTTING COMPOUND Developed Especially for CARBIDE and other VERY HIGH SPEED CUTTING TOOLS

Stuart's SOLVOL AQUAMIX Liquid Cutting Compound

Try It Quickly and See The Difference

THE rapidly increasing use of carbide and other high speed tools emphasizes the immediate importance of this original type of cutting fluid. STUART'S SOLVOL Liquid Cutting Compound was developed especially for this exact condition. Where operations run "too hot" for properly applied straight cutting oils — and where ordinary soluble cutting oils or soluble paste compounds fail to produce satisfactory finish or tool life — that's the place for this original Stuart Oil development.

WIRE TODAY for working sample — FREE to any industrial concern working on defense orders. To assure proper application please tell us name of part, stock, machine and cutting operations.

For All Cutting Fluid Problems

D. A. STUART OIL CO.

Chicago, U.S.A. • LIMITED • Est. 1865

Warehouses in All Principal Metal Working Centers

ening, allowance being made for fitting of the base plug and finishing of the band score and bourrelet. After hardening of the point, projectile is sand-blasted, the band score is finished, the band is pressed on, the cap and wind-shield are fitted, the bourrelet is ground, the band is turned to size, and the base plug is fitted.

Among the principal reasons for use of chromium-nickel steel are its high resistance to shock and the increase in hardening power and depth of hardened layer conferred on nickel steel by the addition of chromium. Caps of armor-piercing shell are made of the same steel as the body but the content of alloying elements is somewhat lower. The exact reason why more successful penetration is obtained by the use of a cap does not seem to be known.

The principal problem in the manufacture of high-explosive shell for anti-aircraft work or ordinary land operations is production volume. The X1335-40 high-sulphur-manganese steels with yield points of 40,000-60,000 lbs./in.^{2} are used for this purpose in the U. S. The Canadians prefer a steel with about 0.52% C and 0.82 Mn. These steels have fibrous structures, and when cooled at moderate rates their strength and hardness are increased. Thus, they permit easy machining and eliminate the need for special heat treatment. MS (2a)

New Furnaces and Atmospheres

A Composite

Generally speaking, the present period is not regarded as one in which it is wise (or even possible) to be preoccupied with the development of new designs or new models of such defense-vital units as heat treating furnaces and atmosphere producers. But certain recent installations and developments, which have been "in the making" for the last few years are actually extremely timely as a direct contribution to the faster production and more efficient operation demanded today.

Thus, a higher-production, more conveniently-operated strip annealing furnace of the radiant-tube type is described in *Steel* ("Improved Radiant-Tube Strip Annealing Furnace," Vol. 108, Apr. 14, 1941, pp. 66, 69). The furnace is a new design bell-type unit at the plant of Superior Steel Corp., Pittsburgh.

Strip Annealing

The furnace consists of 3 bases, 3 new-type firing retorts, and 1 furnace bell. Each base contains a high-capacity recirculating fan and has an oil seal. The firing retort is an inner cover containing a number of return-bend radiant tubes. The lower part is refractory-lined up to the point where the conical alloy hood is welded to the structural steel casing.

Each tube is welded to this casing at the firing end, while the exhaust end is welded to the alloy sides. The tube is held in place at the return bend but can float free to meet expansion requirements. The furnace bell is only an insulated cover for retaining heat.

Natural gas is burned; recirculating fans handle 2500 cu. ft./min., and the atmosphere is partially-burned natural gas, dried to 45° F. dew-point. Dual-pressure combustion is used, with both gas and air supplied at a constant low pressure.

The total radiation surface is twice that of former design and heat transfer and recuperation have been greatly improved. Results show that greater tonnage is being annealed with 20% lower fuel consumption. This furnace can be cooled faster by blowing air through the radiant tubes —a 12,000-lb. charge is cooled in 22 hrs., as compared with former cooling time of 30 hrs.

Batch Annealing

With another new furnace—a batch-type tube annealer described by J. J. B. RUTHERFORD & N. HAMILTON of Babcock & Wilcox Tube Co. ("Precise Heating-Cooling Cycles Afforded by New Batch-Type Annealing Furnace," *Steel*, Vol. 108, May 26, 1941, pp. 88-89, 95, 96)—the annealing cycle has been reduced more than 50% and product uniformity greatly improved.

The job is the annealing of S.A.E. 52100 bearing tubing, and in the conventional open-fired or radiant-element furnace the cycle has been 45-60 hrs. In the new convection-type furnace, the cycle requires 20-30 hrs., and fuel consumption has been lowered to 1800-1900 ft.^{3} of gas per ton of steel, from the former figure of 9,000 ft.^{3} per ton.

The furnace—a 16-20 ton capacity unit—is described as the closest approach thus far to a batch-type furnace capable of treating large tonnages with the same degree of accuracy and response to control normally obtained only in small laboratory furnaces. Its maximum operating temperature is 1600° F., and it is almost entirely lined with firebrick.

Case-Hardening

A new type of continuous gas furnace used for light case-hardening of small parts for 1941 Buicks is described in *Heat Treating & Forging* ("Unusual Type of Small-Parts Hardening Furnace," Vol. 27, Apr.

STRATEGIC MATERIAL UNDER FIRE...

Furnace for manufacturing tungsten at plant of Cleveland Tungsten Company. Heating chambers are Inconel tubes, boats for carrying tungsten compound are Nickel, and loading end has cast Monel fittings with Monel* tubes.*

REDUCING TUNGSTEN AT 1650° F. CALLS FOR EXCEPTIONALLY HEAT-RESISTANT FURNACE PARTS

In producing tungsten, chemical derivatives of the native ore are reduced under heat in an atmosphere of flowing hydrogen. Subjected to 1650° F., the closed tubes employed in the process are made of Inconel.

Few metals could long withstand this combination of high temperature and reducing atmosphere. But Inconel has the required characteristics. Tough, strong and unusually resistant to heat, this durable high-nickel alloy resists flaking and spalling, assures long, dependable performance.

The many advantages of Inconel at high temperatures, listed below, are widely recognized. As a result, this useful alloy is widely used for industrial furnace parts and accessories, airplane exhaust manifolds and other equipment vital to national defense.

For information on Inconel write for Bulletin C-8, "High Temperature uses of Monel, Nickel and Inconel." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET NEW YORK, N. Y.

ADVANTAGES OF INCONEL AT HIGH TEMPERATURES

1. Maintains high strength and ductility.
2. Very resistant to oxidation. Oxide adherent, does not readily scale off.
3. Resistant to carburization.
4. Resistant to the effects of nitriding gases.
5. Resistant to hydrogen, cracked ammonia and other protective atmospheres.
6. Makes ductile welds, not subject to intergranular deterioration.
7. Free from excessive distortion during sudden temperature changes, due to low coefficient of thermal expansion.
8. Readily formed into complicated shapes.

INCONEL

*"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Company, Inc.

1941, pp. 187-189). Temperatures are controlled in 3 zones, the operating temperature being 1500°-1525° F. Furnace capacity is 1500 lbs./hr., with each part in the furnace 1½ hr. at 1500° F.

The furnace is heated by gas-fired radiant tubes, and the case-hardening gas is a mixture of prepared gas, city gas, propane and ammonia. The gas is prepared in a patented generator by partially cracking 1.7 parts of air and 1 part city gas inside an externally-heated alloy bottle. The cracked mixture is passed through a dehydrator and hot charcoal, and then admitted to the furnace and circulated.

Parts are pushed through the furnace in specially-designed trays, 2 rows of which ride side-by-side on alloy steel rails, the trays being moved by a pusher mechanism at the charging end. No conveyor chains or dogs are required inside the furnace.

As the trays enter the discharge vestibule after heating, they are automatically placed on an elevator, and lowered into an oil-quench tank. In the oil the trays rest on an inclined chain conveyor that moves them up and out of the oil for unloading.

Atmospheres

The problems associated with controlled atmospheres are discussed by J. A. GIER of Westinghouse ("Controlled Gas Guards Steel," *Am. Machinist*, Vol. 85, Apr. 2, 1941, pp. 284-285) with special attention to the new atmosphere known as "Endogas" —formed by the endothermic reaction of a hydrocarbon fuel and air in a special generator, without subsequent scrubbing and drying.

A very good brief review of modern furnace atmospheres for steel treatment is given by "ROVA" ("Possibilities of Modern Furnaces and their Atmospheres in the Bright Heat Treatment of Steel," *Sheet Metal Inds.*, Vol. 15, Apr. 1941, pp. 483-485). *Ratios* are properly emphasized as the controlling factors—thus the ratio of methane to hydrogen is more important commercially than the exact amount of either. Also, the considerable effect of any sulphur present in the gas, in increasing the amount of scaling, is stressed.

Atmosphere Generators

A very useful descriptive review of the broad principles underlying new types of generators for controlled atmospheres is given by E. E. SLOWTER & B. W. GONSER of Battelle Mem. Inst. ("Controlled Atmosphere Generators; Recent Advances in Equipment," *Metal Progress*, Vol. 39, May 1941, pp. 560-566, 628).

Nitrogen generators are now made in a complete unit, where a fuel gas is completely burned with the proper air mixture and the water and carbon dioxide subsequently removed from the product gas—or they may consist of separate units, one of which produces the burned gas and the other removes the objectionable components.

Carbon monoxide-nitrogen mixtures made from the combustion of carbon in air are now available commercially and seem to be highly successful. One generator of this type passes the air over charcoal or coke at the same temperature as the steel being treated, the basic principle being that an atmosphere in equilibrium with carbon at a given temperature will be non-decarburizing and non-oxidizing to any steel *at the same* temperature. The charcoal or coke is pre-heated in the apparatus to remove harmful reactants.

Gas-engine exhausts have been commercially used for controlled furnace atmospheres. One unit consists of a gasoline engine, a condenser for cooling the exhaust gases, and a receiver for additional condensation and for smoothing out the exhaust pulsations. The engine may burn straight gasoline, natural gas, city gas, etc. The high explosion temperature is said to produce a more stable atmosphere than that from ordinary flame combustion.

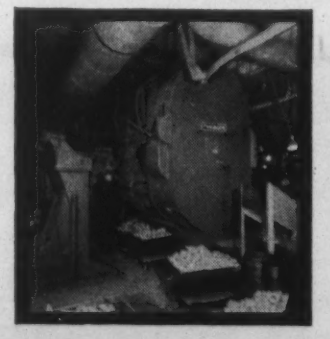
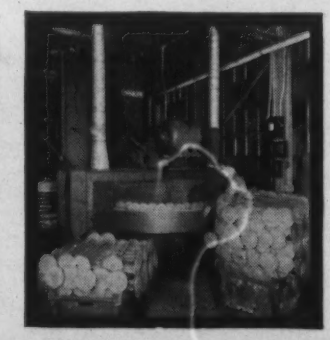
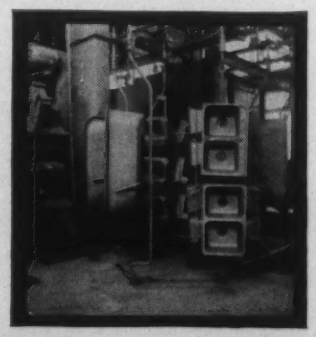
Recent trends have been toward the production of atmospheres as nearly as possible in equilibrium with the steel to be protected. Most success has been had with fairly large-scale equipment available to protect any hot metal, but which is expensive and dependent on careful technical operation. The greatest need for improvement is in simpler, cheaper, small-scale equipment for the small heat-treater and intermittent user. X (2a)

Reclaiming Spent Pickling Baths

"THE RECLAMATION OF WASTE PICKLE LIQUOR." J. H. G. WILLAN. *Sheet Metal Inds.*, Vol. 15, Apr. 1941, pp. 487-489; 491. Practical.

Most waste pickle liquor consists of free sulphuric acid contaminated with ferrous sulphate ($FeSO_4$). There are 3 methods for reclamation, all of which are outlined below.

In the first method, all discarded liquor is converted into sulphur dioxide gas, then into sulphuric acid. (a) The free acid is neutralized before the liquor is evaporated to a residue, which is introduced together with pyrites into a roasting kiln. The sulphur dioxide is con-

BARRELS, TABLES, SPECIAL CABINETS
ROTOBLASTING speeds work!
No matter how tough the test—how difficult the problem—turn to Pangborn for blast cleaning that is QUICKER, CHEAPER and BETTER.
If pushed for production—install airless ROTOBLASTING—use it twenty-four hours a day—seven days a week. Pangborn Barrels, Tables and Special Cabinets have stamina and strength—have proven they can take it—BY CONTINUOUS INCREASED PRODUCTION.
For speed—for control—for lower cost cleaning—shift gears quickly into ROTOBLASTING. Costs have dropped as much as 50%. Production has increased as high as 80%. And quality goes up to the very top.
For quickest possible delivery—place tentative orders NOW.



WORLD'S LARGEST MANUFACTURER OF BLAST CLEANING & DUST CONTROL EQUIPMENT
PANGBORN
PANGBORN CORPORATION · · · HAGERSTOWN, MD.

verted to acid by the contact method. The iron oxide formed during roasting can be used for the neutralization.

Or, alternatively (b) the free acid is neutralized with steel scrap, then the liquor is concentrated by heat until $FeSO_4 . 7H_2O$ crystallizes out. The salt is recovered in centrifuges, while the mother liquor is returned to the evaporators. The salt is calcined to give iron oxide and SO_3 which can be converted to sulphuric acid by combining with water.

In a second method the iron sulphate is separated from the mother liquor, and converted into sulphuric acid. The mother liquor after enrichment with fresh acid is returned to the pickling tank. (a) In the Mantius adaptation of this, the ferrous sulphate is separated from the liquor by a 2-stage concentration, as it is almost insoluble in 68% acid. The main disadvantage is that the impurities accumulate in the liquor until they become detrimental to pickling and the mother liquor must be discarded. (b) The Marsh-Cochran modification uses artificial refrigeration to cool the waste liquor to a point where 50-70% of the iron sulphate crystallizes out and can be removed. The mother liquor is returned to the pickling tanks.

In a third method the free acid is neutralized either with steel scrap or an alkali. The liquor is then evaporated to remove excess water and recover the ferrous sulphate. The remaining liquor is either returned to the system just before the evaporators or discarded. In another variation, the waste liquor is discharged onto waste ground which contains a neutralizing agent.

A recent proposal is known as the Ferron method which appears to have far greater possibilities than anything so far developed. The liquor is neutralized by alkalies; the precipitate which is composed mainly of co-precipitated iron hydroxide and calcium sulphate is recovered as a compact substance that may be used as an insulator or wood substitute. There seems to be much more of a market for this material than for ferrous sulphate.

JZB (2a)

12b. Non-Ferrous

Tinning and Soldering Copper

"Tinning and Soldering Copper." R. T. Seckerson. *Sheet Metal Inds.*, Vol. 15, Apr. 1941, pp. 523-526. Practical.

Tinning or the production of an adherent film of tin or solder on copper involves, first, wetting of the surface, and then alloying. The flux serves to ensure that clean molten solder comes in contact with the clean basis metal.

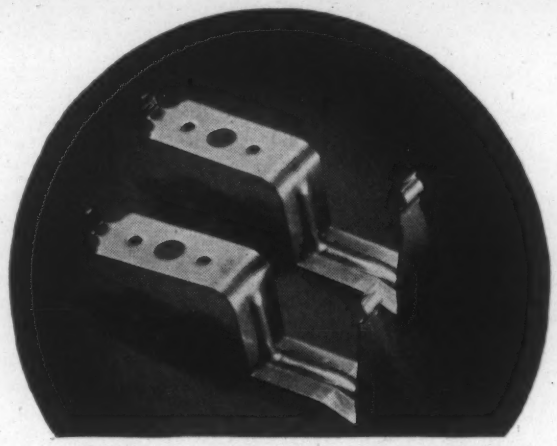
Tests were made on 3 types of flux: a resin-base liquid flux, rather slow in action, but completely non-corrosive; oleic acid, somewhat more active; and a fluid solution of inorganic chlorides (composition not given) of the active type. All were satisfactory on cleaned copper; but when the copper had been oxidized at 850°F., the first was completely unsatisfactory, the second only fair, but the third good.

However, the first type is ideal for electrical and radio work where the joints can not be cleaned, since the residue is non-corrosive. Oleic acid does exert some corrosive action on copper if not removed, while the active fluxes cause marked corrosion unless thoroughly removed (*i.e.* by washing in 1% HCl).

In hand soldering, the soldering iron should be as heavy as possible because of the high thermal conductivity of copper. High-tin solders are expensive, but this is often compensated for by the ease of working; also the strength of soldered brass lap joints increases from 4,400 lbs./in.^{2} for 15% Sn to 6,100 lbs./in.^{2} for 63% Sn. The effect of 2% Sb is about equivalent to increasing the tin by 4%, as far as the melting point is concerned; furthermore, the addition of 2.5—3% Sb to a 50% Sn solder increases the tensile strength from 8,400 lbs./in.^{2} to 9,680 lbs./in.^{2} while the melting point is decreased slightly from 410°F. to 401°F.

Hot dipping is used for soldering complicated assemblies, for producing a surface which is readily soldered, and for obtaining a durable, corrosion-resistant coating. The main precaution is that the copper must be clean. Degreasing may be necessary, but often only an acid dip is needed (dilute hydrochloric acid, cold 10% nitric; hot 11% sulphuric + 2% nitric acid). The copper should be washed after the acid dip.

Liquid fluxes are required in hot dipping. The dipping temperature should be kept at a minimum to avoid formation of excessive amounts of intermetallic compound, discoloration of the coating, drossing, and unusually thin coatings because of greater fluidity of the solder. Also, if the temperature of the dipping bath is too high, and the dipping time too long, the solder becomes contaminated with copper making it viscous and gritty. Copper contamination is not as troublesome with lead-tin solder as with pure tin.



BRIGHT HARDENING

ONE OF THESE SPRINGS HAS BEEN HARDENED . . . AND ONE HASN'T

WHICH IS WHICH?

Does your production involve the hardening of springs, stampings, screw machine parts or other such small to medium size items? If so, you've probably wondered how you could harden those parts without scale or discoloration. You can! And not only harden them without scaling or discoloring, but harden them bright, so bright that you can place an unhardened piece beside one that has been hardened and not be able to tell which is which. Hundreds of thousands of springs and other parts are being BRIGHT HARDENED every day by means of the Hydryzing Process, and because Hydryzed parts come from the quench with their bright original finish, hundreds of dollars are being saved each week in the elimination of sandblasting and other cleaning costs. Consider the savings Hydryzing will make in your plant, in time, in labor and cleaning supplies *plus* the greatly improved appearance of the parts over those hardened by older methods. Just drop us a note and we'll send a packet of Hydryzed samples and descriptive literature.

LINDBERG ENGINEERING COMPANY
224 NORTH LAFLIN STREET CHICAGO, ILLINOIS

CUTS COST—SPEEDS PRODUCTION: Actual tests show Hydryzing increases production of small parts as much as 85% because of simplified handling. Sandblasting and cleaning are eliminated. No lost time while parts go to other departments for cleaning

BETTER APPEARANCE—NO SOFT WORK: Sandblasting or pickling always pits surfaces of work, however minutely Hydryzed work has original smooth shiny surface so that plating is smooth and lustrous. Less buffing is needed to produce full lustre. Hydryzed parts are fully hard because they are completely protected, while in furnace, against loss of carbon. Also, their clean, scaleless surfaces receive full benefit of quench insuring uniform hardness on every lot.

LINDBERG CYCLONE FOR TEMPERING HYDRYZING FOR HARDENING

The weight of solder should be at least 10 times that of the article being dipped to avoid temperature fluctuation. The dipping temperature is usually about 90°F. above the melting point, although it may vary with conditions of service. Quenching in water usually produces a frosty appearance, but "rapid" solidification helps to preserve the brightness and uniformity of the surface. JZB (2b)

Welding Light-Metal Aircraft

"Welding of Light Aircraft." "Observer." *Sheet Metal Inds.*, Vol. 15, Mar. 1941, pp. 385-391. Practical.

Welding is quicker and cheaper than riveting, but not always as dependable. In gas welding the overall strength of a welded joint can not exceed that of the cast or dead-soft metal. Moreover, the weld metal may contain various flaws which reduce the strength still further.

The weld itself can be improved by cold working, but the heat affected metal on each side cannot be so treated. The extent of this softening can be reduced by use of the Weibel metallic arc process, but this method is applicable only to a limited range of joints and can not be applied as yet to thin sections of light metals as used in aircraft.

Although there are not many applications, there is a growing tendency to replace castings by weldings of thinner section in a material of higher mechanical properties than the usual aluminum-silicon cast alloys, thus obtaining a saving in weight. Engine fairings and cowlings (produced by spinning and pressing) have welded joints and may also be welded to the rest of the machine. Some small but essential fittings (such as ailerons) are flame-welded, but it is not advisable to attempt welds between sheets and heavier sections.

Gasoline and oil tanks are made either of plastics or of welded pure aluminum or magnesium alloy. Interior fittings such as chairs are welded, while gas welding is widely used in repair work. Some "low temperature" processes such as that of Lenssens may be of value but are little used at present.

Spot welding requires more expensive equipment than flame welding, and there are few reliable data for design purposes. Such data are particularly important, since spot welds must carry sheer, tensile, and bending stresses. Welding practice must be carefully controlled, but even then there is still a scatter of as much as 25% of the mean value of strength, so usually 60-70% of the mean strength is used for design.

The size of the spot is important in determining its strength. Pores and cracks are not as detrimental as an unduly large spot which extends to the outside of the sheet. The most important weakness is a "notch" effect at the edge of every spot leading to a very high stress concentration. Parallel lines of spots are better than staggered rows.

Spots that are too close together reduce the total strength, and are also individually weaker because of short-circuiting through the previous weld (for example with 0.036 in. sheet, the center of the spot should be 0.235 in. from the edge of the sheet and 0.335 in. from the center of the next spot.) Jigging may be required, but should be a minimum due to the expense of the jig and the time required for loading and unloading.

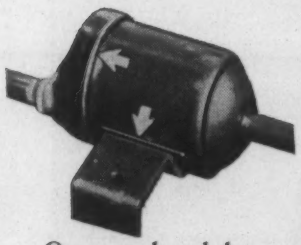
The limits of thickness are about 0.004 to 0.15 in. Alloys are usually easier to spot weld than high purity aluminum, while magnesium alloy can also be spot welded. Assemblies embodying spot welds include cowlings, seats, interior fittings, built-up spars, small girders (where spots are used exactly as rivets were previously), rudders, ailerons, and fuselage coverings. Fuel tanks are sometimes welded by means of a seam welder.

Spot welding should be very accurately controlled: a standard finish should be obtained by means of etching, as, for example, with a hydrofluoric acid paste etch for 30 secs. Sites of spots should be marked. Components must be held by jigs, clamps, or by tack welds before welding.

Welding conditions should be firmly established and maintained. Some machines have a "programme control" to heat treat the weld in Alclad or duralumin to increase the strength. If the machines do not have this feature, it may be necessary to heat treat the completed component. In some cases, the welds should be examined by X-ray, but small defects are not always disclosed. JZB (2b)

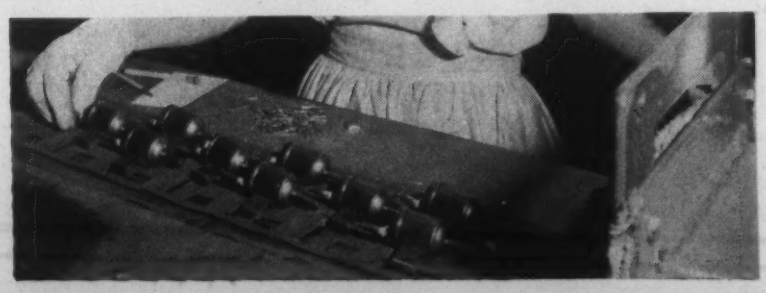
You can get **HIGH PRODUCTION** *like this* **RELIABLY**

WITH EASY-FLO BRAZING



On each dehydrator a ring of 1/16" EASY-FLO is placed between the body and head. They are placed on the moving belt, with the bracket in place, and a straight piece of 1/16" EASY-FLO wire is laid between the body and bracket, as shown in the enlarged view above.

All you need is a production set-up planned to take full advantage of the fast, reliable brazing that EASY-FLO makes possible. In the case of these Monel metal dehydrators a head and a bracket must be brazed to each dehydrator body. The heating set-up consists of an endless belt, moving at predetermined speed through an electric furnace.



Completely brazed dehydrators come out of the furnace, with alloy set, at the rate of 400 per hour. The ability of EASY-FLO to make liquid and gas-tight joints at high production rates between ferrous, non-ferrous and dissimilar metals is due to its extreme fluidity, low working temperature (1175°F) and the fact that it contains silver. You will find full details in our Bulletin MA10. Write for a copy. If metal joining production is one of your problems, we'll be glad to send a field engineer to show you what EASY-FLO can do.

HANDY & HARMAN 82 FULTON ST., NEW YORK

Agents in Principal Cities. In Canada: HANDY & HARMAN of Canada, Ltd., Toronto

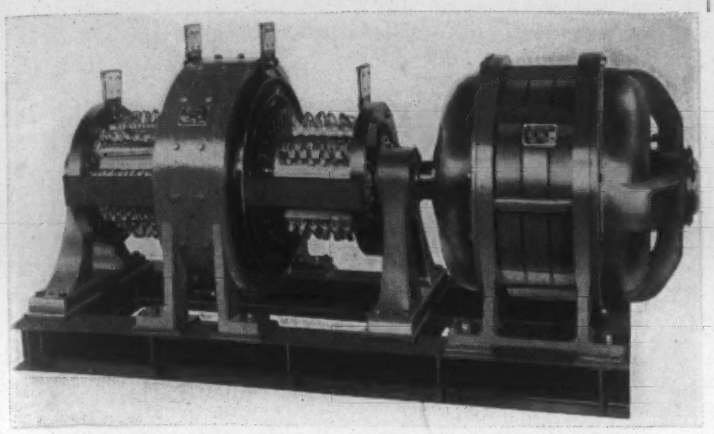
Annealing Behavior of Zinc Alloys

"Recrystallization of Zinc and Zinc-Copper Alloys ("Ueber die Rekristallisation von Zink und Zink-Kupfer-Legierungen") G. Masing & H. Staunau. *Z. Metallkunde,* Vol. 33, Feb. 1941, pp. 74-81. Original research.

The object of this work was to determine (1) the relation of the beginning of recrystallization and of the grain size after

COLUMBIA MOTOR-GENERATORS

for Electro-Plating and other Electrolytic Processes



Columbia Motor-Generator Sets are a valuable asset in meeting the precision requirements of the modern plating department and embody every feature essential to dependable, 24-hour operation. They are built in sizes of ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts. Prompt shipment can be made on any size.

COLUMBIA ELECTRIC MFG. CO.
4508 Hamilton Ave. Cleveland, Ohio

STEWART

THE BEST INDUSTRIAL FURNACES MADE

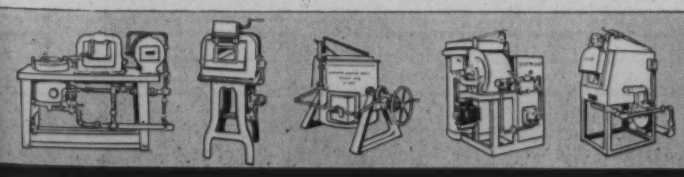
IT'S AMAZING HOW MUCH MONEY CAN BE SAVED WITH *MODERN* HEAT TREATING EQUIPMENT

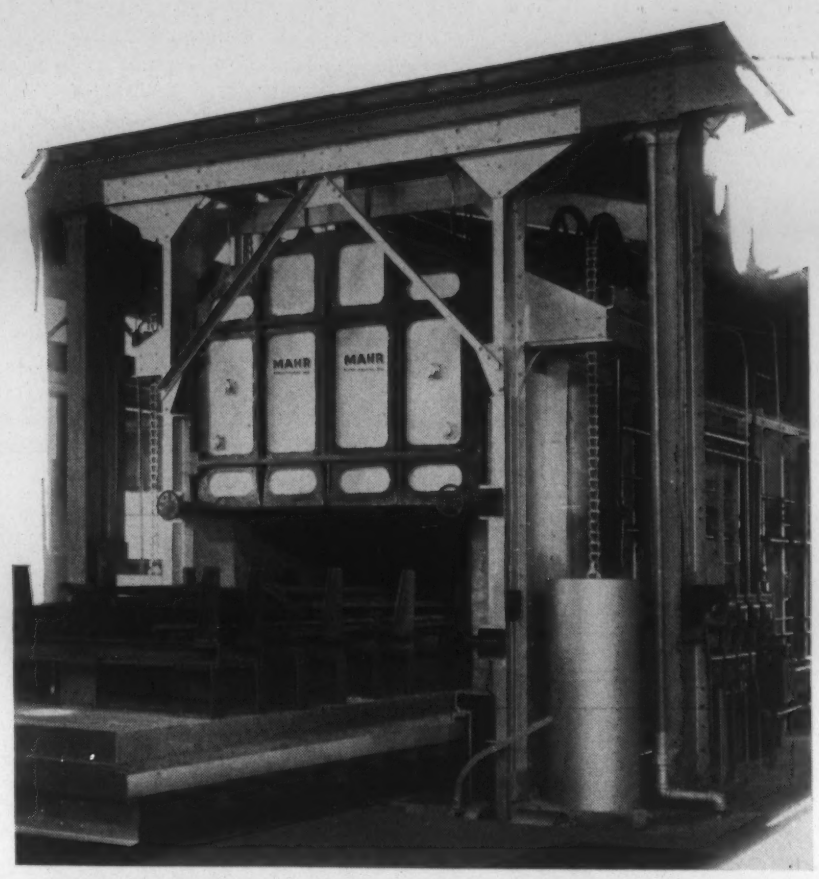
Industrial Furnaces of All Kinds
Forging, Heat Treating, Metal Melting, etc.
Car Type Furnaces, Conveyor Furnaces, and the Stewart Gasifier.

•

A Stewart representative is located near you. Let us know and we will see that he gets in touch with you quickly.

CHICAGO FLEXIBLE SHAFT CO.
1103 South Central Avenue, Chicago, U. S. A.
FLEXIBLE SHAFT CO., Ltd., 321 Weston Rd., S., Toronto, Ontario, Can.
***Eastern Branch Office:* 11 W. 42nd St., New York, N.Y.**





BEHIND THE SCENES IN DEFENSE—

MAHR FURNACES

ARE DOING DOZENS OF IMPORTANT HEAT TREATING JOBS EVERY DAY

In airplane plants—in munitions, armament, ship building and other defense plants, as well as in peace time industry—MAHR furnaces are daily annealing, carburizing, normalizing, nitriding, and generally heat treating thousands of tons of steel and other metals. For over 25 years industry has relied upon MAHR furnaces and ovens, because they are utterly dependable for capacity of delivered heat, uniformity of temperature, strict economy of operation and modern design and equipment.

MAHR HAS PIONEERED

During more than 25 years, MAHR engineers have pioneered many of today's standard features and designs, among them the rotary type furnace now used so successfully in certain types of defense work, and the N_2 generator which delivers a controlled pure nitrogen atmosphere for heat treatment of high carbon and alloy steels.

LET MAHR ENGINEERS CONSULT WITH YOU

The thousands of industrial heat applications made by our engineering staff have resulted in the solution of a mass of heat problems. This experience and the skill of these experts are at your service whether your needs are large or small.

MAHR PRODUCTS
Rotary, Car types, Conveyor types, Roller Hearth and Pusher types, Open Front Batch and Forging, Tool, Pot, Crucible and Babbitt, Rivet Heaters, Torches, Babbitt Pots, Forges, Core Ovens, Ladle Heaters

ADDRESS INQUIRIES TO DEPT. MA7

MAHR MANUFACTURING CO.

recrystallization of pure zinc to the initial grain size, and (2) the changes in the beginning of recrystallization and in the grain size after recrystallization caused by the addition of copper to pure zinc.

Electrolytic zinc of 99.99% purity was remelted and cast into iron molds. The copper-zinc alloys contained 0.1, 0.3, 1.0 and 3.0% Cu added as electrolytic copper. Samples were rolled 1, 2, 4, 6, 8, 10, 15, 20, 50, 60 and 80% and annealed between 200° and 465°F. for 30 min. To determine the "secondary recrystallization" of zinc, samples were preannealed at 120°F. for 30 min. and then heated to 465°-536°F.

In contradistinction to some other metals, no differences in the beginning of recrystallization of zinc as determined by X-rays on one hand and microscopically on the other were observed. The disappearance of deformation twins, even if only at one place, was taken as the beginning of microscopic recrystallization, and the disappearance of the last deformation twin as the end.

With pure zinc and a zinc-copper alloy containing 0.1% Cu, the size of the recrystallized grain decreases with decreasing initial grain size before cold working. This holds particularly for small amounts of plastic deformation. The beginning of the free, "secondary" recrystallization of zinc is shifted to lower temperatures with increasing deformation by rolling; the secondary grain size is decreased considerably in this way.

The beginning of recrystallization of zinc is shifted to higher temperatures by alloying copper with it. Above the limit of solid solution, copper has no further effect. The grain size of primary recrystallization is markedly reduced by the addition of copper even in the heterogeneous alloy range. The secondary recrystallization becomes obliterated through the addition of copper.

The isothermal velocity of grain growth of the secondary recrystallization was determined with pure zinc. The linear velocity of grain growth is almost independent of time, but is affected greatly by the thermal treatment below the temperature of secondary recrystallization. After rolling 20%, pure zinc begins to recrystallize locally immediately. Zinc rolled 40% is completely recrystallized after one day.

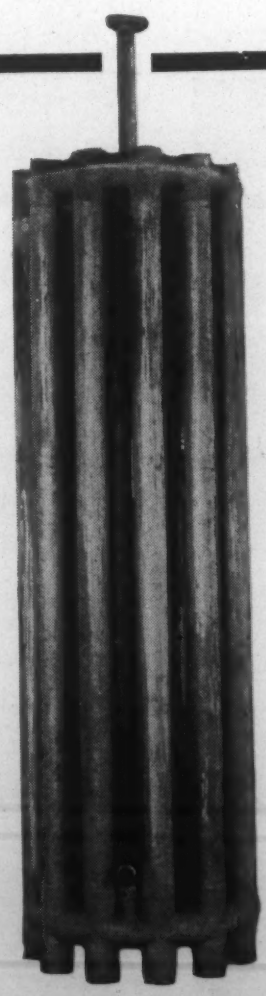
EF (2b)

DURALOY

can do the unusual in

CHROME-NICKEL

CASTINGS



A reaction chamber for a chemical plant consisting of centrifugally cast tubes welded to statically cast parts into the assembly as illustrated! The unit weighs some 2200 pounds.

Such high alloy castings are out of the ordinary and are indicative of what Duraloy experienced metallurgists and foundrymen can do. We have at Scottdale, Pa., one of the most modern chrome-iron and chrome-nickel foundries in the country. Electric furnaces, sand control facilities, sand-blasting equipment, heat-treating furnaces, complete machine shop . . . everything to turn out sound castings, finished to any degree desired.

Make Duraloy your source of supply.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa.

EASTERN OFFICE: 12 EAST 41st ST., NEW YORK, N. Y.

DETROIT
The Duraloy Co. of Detroit

SCRANTON, PA.
Coffin & Smith

ST. LOUIS
Metal Goods Corporation

LOS ANGELES
Great Western Steel Company

Quenching Rates and Corrosion of Strong Aluminum Alloys

"Effect of the Quenching Rate on Susceptibility to Intercrystalline Corrosion of Heat-Treated 24S Aluminum Alloy Sheet." Hugh L. Logan. *J. Res. Natl. Bur. Standards*, Vol. 26, Apr., 1941, pp. 321-329. Research.

A study was made of the susceptibility of 24S aluminum alloy sheet to intercrystalline corrosion when cooled from the solution treatment temperature at different rates by quenching in water maintained at different temperatures. Sheets of the alloy, with copper contents of 4.05, 4.27, and 4.64%, were employed.

Temperatures throughout the cooling were determined from photographically recorded time-temperature curves obtained with a string galvanometer and thermocouples that were attached to the specimens. Susceptibility to intercrystalline corrosion was determined by metallographic examination of the heat-treated specimens after they had been immersed in a sodium chloride hydrogen peroxide solution.

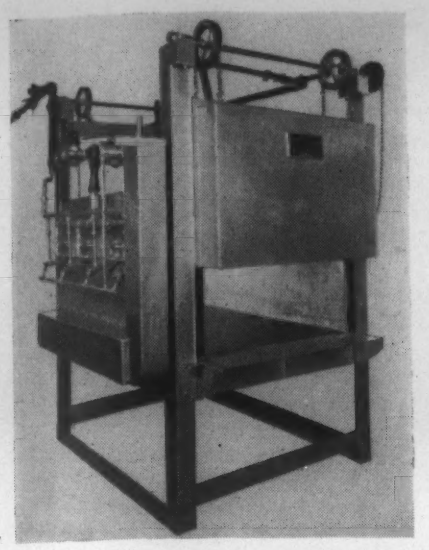
The rate at which a specimen of 24S alloy must be cooled in order to render it resistant to intercrystalline corrosive attack varies with the copper content of the material. Specimens of the alloy containing 4.64% Cu, cooled at rates greater than 1980°F./sec., were subject to pitting corrosion only, with no traces of intercrystalline corrosion. Specimens of the same material cooled at rates less than 720°F./sec. were severely attacked by intercrystalline corrosion in the salt solution. Specimens cooled at intermediate rates showed both pitting and the intercrystalline types of corrosion.

Pitting predominated in the specimens cooled at rates approaching the higher one, and as the cooling rate approached the slower of the two above rates, the intercrystalline attack became more severe. Similar results obtained with specimens of 24S alloy having lower copper contents showed that the lower the copper content, the lower the cooling rate required to render the material immune to intercrystalline corrosion.

Specimens withdrawn from the heating furnace at the recommended solution treatment temperature of 920° F. and permitted to cool in air to a temperature not below 720° F. could be quenched so as to be resistant to intercrystalline corrosion; but if they were permitted to cool below this temperature before they were plunged into the quenching bath, they were subject to intercrystalline corrosion in oxidizing salt solution, regardless of the rapidity of the cooling rate in the quenching bath.

WAT (2b)

FASTER CIRCULATION OF HOT GASES



produces **MORE WORK** *with* **LESS SCALE!**

WALL-TRENT MODEL W Gas-fired Furnaces offer a basic improvement in the placement and spacing of flues and burner parts which results in a more vigorous circulation of gases and eliminates all danger of flame impingement. . . . Easily controlled air-gas ratio, plus a slight positive inside pressure, prevents air infiltration and keeps the work from scaling. . . . Best quality refractory backed by a low heat conductivity block keeps heat losses at a minimum.

Write for Descriptive Bulletins. Model W Series

TRENT *ENGINEERING LABORATORIES*

316 NORTH 22nd ST. PHILADELPHIA, PA.

Is that job PROTECTED

by arc welded sturdy custom made

Heat Treating Baskets?

Baskets designed for strength and safety — with the frame protecting the mesh — with no wire ends to scratch the work or injure the hands of the operator.

It is

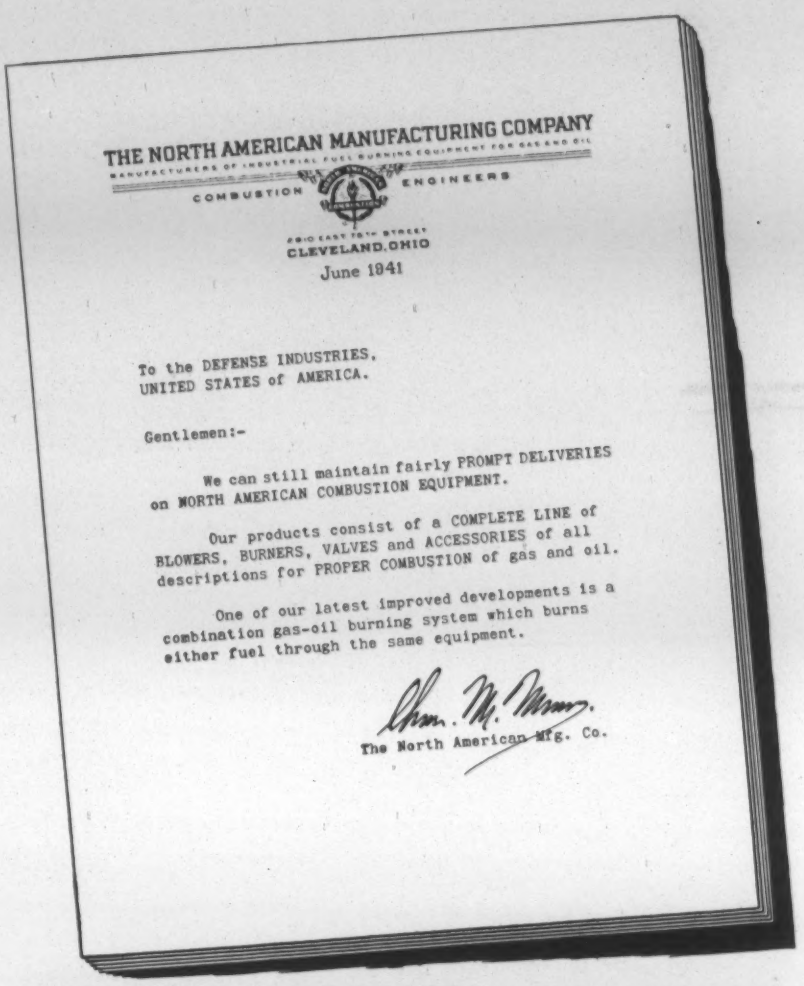
if you are using Rolock, because Rolock is a specialist in this field — producing quality crates and baskets for every industrial need.

Your job needs the protection of Rolock

Write for our catalog . . . . Contains over 50 suggestive illustrations of basket types.

ROLOCK INC.

11 STATION ST. SOUTHPORT, CONN.



THE NORTH AMERICAN MANUFACTURING COMPANY

MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS AND OIL

COMBUSTION ENGINEERS

2810 EAST 79TH STREET

CLEVELAND, OHIO

June 1941

To the DEFENSE INDUSTRIES,
UNITED STATES of AMERICA.

Gentlemen:-

We can still maintain fairly PROMPT DELIVERIES on NORTH AMERICAN COMBUSTION EQUIPMENT.

Our products consist of a COMPLETE LINE of BLOWERS, BURNERS, VALVES and ACCESSORIES of all descriptions for PROPER COMBUSTION of gas and oil.

One of our latest improved developments is a combination gas-oil burning system which burns either fuel through the same equipment.

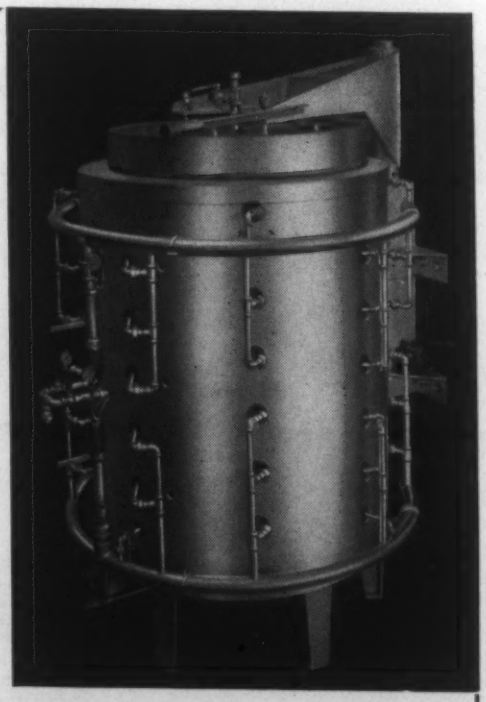
Chas. M. Munn.

The North American Mfg. Co.

NORTH AMERICAN *for* COMBUSTION

MANUFACTURING COMPANY . . . . CLEVELAND, OHIO

NEW IMPROVED VERTICAL GAS CARBURIZER



The retort and cover with sand seal are entirely enclosed in the furnace assuring temperature uniformity of a high order and marked improvement in the uniformity of carburizing.
May also be used for rehardening, annealing, etc., in a controlled gas atmosphere.
Available in various sizes, the larger ones are provided with a pneumatic cylinder for raising the cover so that it can readily be swung to one side.

Write for our new Condensed Catalog describing this furnace and numerous other modern furnaces and Heating Machines.

American Gas Furnace Co.

Elizabeth, New Jersey

3 Design and Applications

METALS, ALLOYS, METAL FORMS
ENGINEERING DESIGN, METAL SELECTION

Physical and Mechanical Properties (including Fatigue and Creep). Corrosion and Wear. Engineering Design of Metal-incorporating Products. Selection of Metals and of Metal-Forms. Competition of Metals with Non-Metals. Specific Applications of Metals and Alloys.

Designing for Powder Metallurgy

A Composite

The manifest advantages of powder metallurgy as a fabricating process for certain types of parts, particularly in designs that would require considerable machining when made by casting, forging, etc. would be more generally enjoyed if engineering knowledge of powder-metallurgy-design were more widespread.

In an editorial in our November 1940 issue, p. 613, attention was called to this need—a need for men who know what can and cannot be designed for powder metallurgy, and who can design parts to take into account the special shape-factors, metallurgical problems and processing limitations and possibilities peculiar to this fabricating method. Broad helpful data that such men could use have recently appeared in articles emanating from companies specializing in the manufacture of parts by powder metallurgy.

Design Fundamentals

Noting that powder metallurgy is a rapidly developing technique that is taking its place beside drop forging, die casting, screw-machine work, plastic molding, etc. as a basic production operation, EARL S. PATCH of Moraine Products Div. ("Limitations of Powder Metallurgy," *Iron Age*, Vol. 146, Dec. 19, 1940, pp. 31-34) urges designers to learn the special design-rules for powder metallurgy, rather than either to attempt to duplicate in the new metal-form a design that was satisfactory for some other fabricating method or to ignore powder metallurgy entirely because of lack of knowledge of it.

The availability and use of relatively inexpensive, good-molding-quality iron powder will tremendously broaden the use of powder metallurgy. A good example of the possibilities is found in spur gears (automotive oil-pump gears, for example), which can be manufactured by powder metallurgy at costs that are ½-¾ the cost of finished gears made by casting-and-machining.

There are a few basic points that metallurgical design engineers should remember in appraising the possibilities and limitations of powder metallurgy for a given part. First, powders do not flow freely in the dies, and therefore re-entrant angles cannot be formed.

Second, length tolerances must be more liberal than those imposed by conventional finishing methods. Third, tolerances on concentricity must be somewhat broader than with other processes.

Fourth, the design must be one that would normally involve a high ratio of machining cost to cost of material. Fifth—depending on the design of the piece—there must be a relatively large number of parts to be made of a given design to carry the expense of tools, dies and equipment. Given really mass-production jobs, "there is practically no method of forming parts that is cheaper than powder".

Materials and Other Factors

Several specific examples of shapes and proportions of machine parts that can be made by powder metallurgy are given by R. P. SEELIG & E. C. GORDON of Powder Metallurgy Inc. ("Designing Powdered Metal Machine Parts," *Machine Design*, Vol. 13, Apr. 1941, pp. 42-44). Material factors are often insufficiently recognized as controlling the feasibility of powder metallurgy for a given design.

Thus, bronze and brass parts made from powders may have as good or better physical properties than the same parts made by casting. At present, parts made from iron or steel powders are on a par with cast iron and low-carbon steel as to strength. In shock-resistance, however, powder compacts are inferior to "wrought" metals.

Dies must be capable of withstanding the pressures of 20 tons to 200 tons/in.^{2} that are used, must permit uniform pressure on all parts of the piece, and must permit ejection after pressing. Undercuts and cross-holes must be avoided even to a greater extent than in die casting.

Dimensional tolerances should be different for different materials. Shrinkage or expansion in sintering varies with the material; furthermore, the percentage of error in any case becomes greater as the part-size increases. Closer radial tolerances can be expected than axial. Narrower

AN IDEAL COMBINATION:

INCREASED PRODUCTION + DECREASED TOOL COSTS

you get both with

JESSOP MOGUL MOLYBDENUM-TUNGSTEN HIGH SPEED STEEL

JESSOP
MOGUL
MOLYBDENUM TUNGSTEN HIGH SPEED STEEL
A comparatively new high speed steel which has proved advantageous for many applications where 18-4-1 high speed steels have been customary.
MADE IN AMERICA
JESSOP STEEL COMPANY
General Office and Works
WASHINGTON, PENNA.

Jessop "MOGUL" Molybdenum-Tungsten High Speed Steel will stay sharp equally as long as 18-4-1 High Speed Steel when used for certain types of tools. On many jobs, MOGUL will average 20% more work than 18-4-1. Furthermore, Jessop "MOGUL" *costs less* than 18-4-1, and its lower hardening temperature substantially lowers fuel costs.

SEND FOR FREE BOOKLET

This new booklet fully describes the properties and heat treatment of Jessop MOGUL Molybdenum-Tungsten High Speed Steel. For your free copy, write JESSOP STEEL CO., 546 Green St., Washington, Pa.

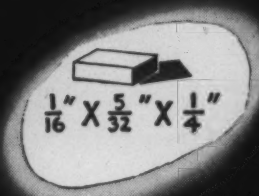
JESSOP STEEL CO. FINE JESSOP STEELS WASHINGTON, PA.

1901 CELEBRATING OUR 40TH ANNIVERSARY 1941

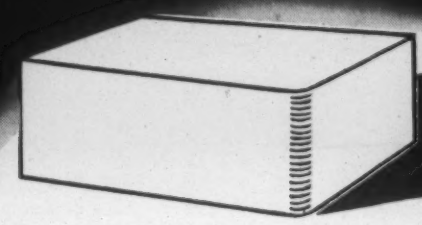
Jessop Steels of America

CARBON · HIGH SPEED · SPECIAL ALLOY · STAINLESS · and COMPOSITE STEELS

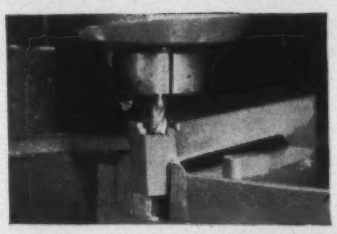
Exactly The SIZE You Need..



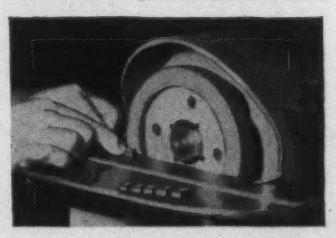
..AND ALL THE WAY BETWEEN..



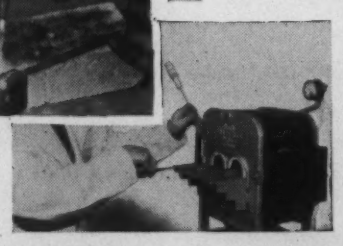
How to make your own FIRTHITE Tools



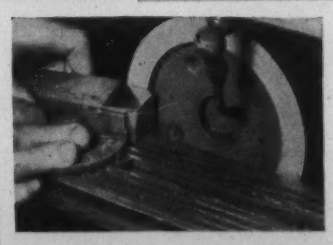
Recess Tool Steel Shank to take Firthite "tip"



Shape Firthite "tip" to fit shank recess



Braze Firthite "tip" into shank recess



Grind clearance angles on assembled tool

A FIRTHITE TIP FOR EVERY TOOL!

From the tiny but effective FIRTHITE Tip, 1/16"x5/32"x1/4", to the husky blank, 1/2"x3/4"x1 1/4" . . . and in hundreds of sizes all the way between . . . you can select a size, shape and grade of FIRTHITE Sintered Carbide Tip to meet your every tool making need.

The recent addition of 176 *NEW* Standard Tip Sizes results in a wide range of 249 sizes embracing almost the whole field of single point tool requirements and a large variety of special tools as well. Increased production facilities assure prompt delivery of both standard and non-standard tips of all sizes.

Join the increasing group of manufacturers who avoid carbide cutting tool delays by making their own FIRTHITE Tools with Firthite tips. If you have not already received one, ask for the new STANDARD TOOL TIP SIZE AND PRICE LIST today!

FIRTH-STERLING STEEL COMPANY

OFFICE AND WORKS:
McKEESPORT, PA.
BRANCH WAREHOUSES:
NEW YORK CHICAGO
HARTFORD PHILADELPHIA
LOS ANGELES DAYTON
CLEVELAND DETROIT

tolerances can be met if the parts, after being pressed and sintered, are coined or sized.

A good example of some of the special design factors is a certain wear-resistant part that could not be stamped out of a hard material but can easily be made by powder metallurgy. Small holes present are more cheaply made by subsequent drilling than by coring the die.

Use of Powdered Steel Turnings

The great importance of the material used in determining the feasibility and economics of a given design for powder metallurgy is interestingly demonstrated in the case of an automotive part made from powdered steel turnings—a development of HERMAN TORMYN of Chevrolet ("Parts Made from Steel Turnings by Compressing and Sintering," *Steel*, Vol. 108, May 26, 1941, pp. 76, 78, 94). The raw material cost here is evidently very low, and the properties of the finished compact are claimed to be better than those of "cast iron".

The part produced is a bearing lock sleeve used to hold the roller-bearing in the differential carrier of Chevrolet cars. It is a heavy round washer, about 3 in. in diam. and 5/8 in. thick, with a section thickness of 3/8 in. One face is smooth, at an angle of about 20°. The other has concentric recesses near the inner and outer edges.

The finished weight is 8-1/8 oz. Formerly, the part was made of gray cast iron. Now it is made from S.A.E. X1112 steel chips and turnings, which have been reduced to particles of fairly uniform size in a crusher. The crushed turnings are compressed in a briquetting press by 30-ton pressure to half their original volume, to form a completely adherent washer.

Comparative tests of cast iron and the sintered steel sleeves were made by gripping half of the ring rigidly and applying a 3/4-in. punch against the side of the exposed part. Failure loads of 3 samples of each were 4,000, 4,090 and 4,950 lbs. for the sintered steel and 1470, 1180 and 1670 lbs. for cast iron. X (3)

Water Corrosion in Refineries

A Composite

Water-side corrosion problems in oil-refinery condenser components are among the most complicated and beshrouded of metal-service matters. Two papers presented before the recent meeting of the American Petroleum Institute have tended to bring some clarification into the general picture, and are worth reviewing here.

A brief yet comprehensive review of the fundamentals of electrolytic corrosion and of the behavior of condenser-coil metals is given by B. B. MORTON ("Water Side Corrosion of Refinery Equipment," *Am. Petroleum Inst.*, Paper, Tulsa Meeting, May 21, 1941, 8 pp.)

The oldest and probably the most commonly used material for refinery condenser coils is cast iron. Its use is restricted to relatively low pressures. Corrosion gradually removes ferrite and leaves a layer of graphitic carbon which either serves as a protective film to the remaining iron, depending upon its porosity, or it speedily accelerates corrosion by virtue of its electrochemical nobility.

Alloying cast iron with nickel, usually about 13-15%, and other elements such as copper (5-6%) and chromium (approx. 2%) confers appreciable corrosion resistance, in some cases five times that of cast iron.

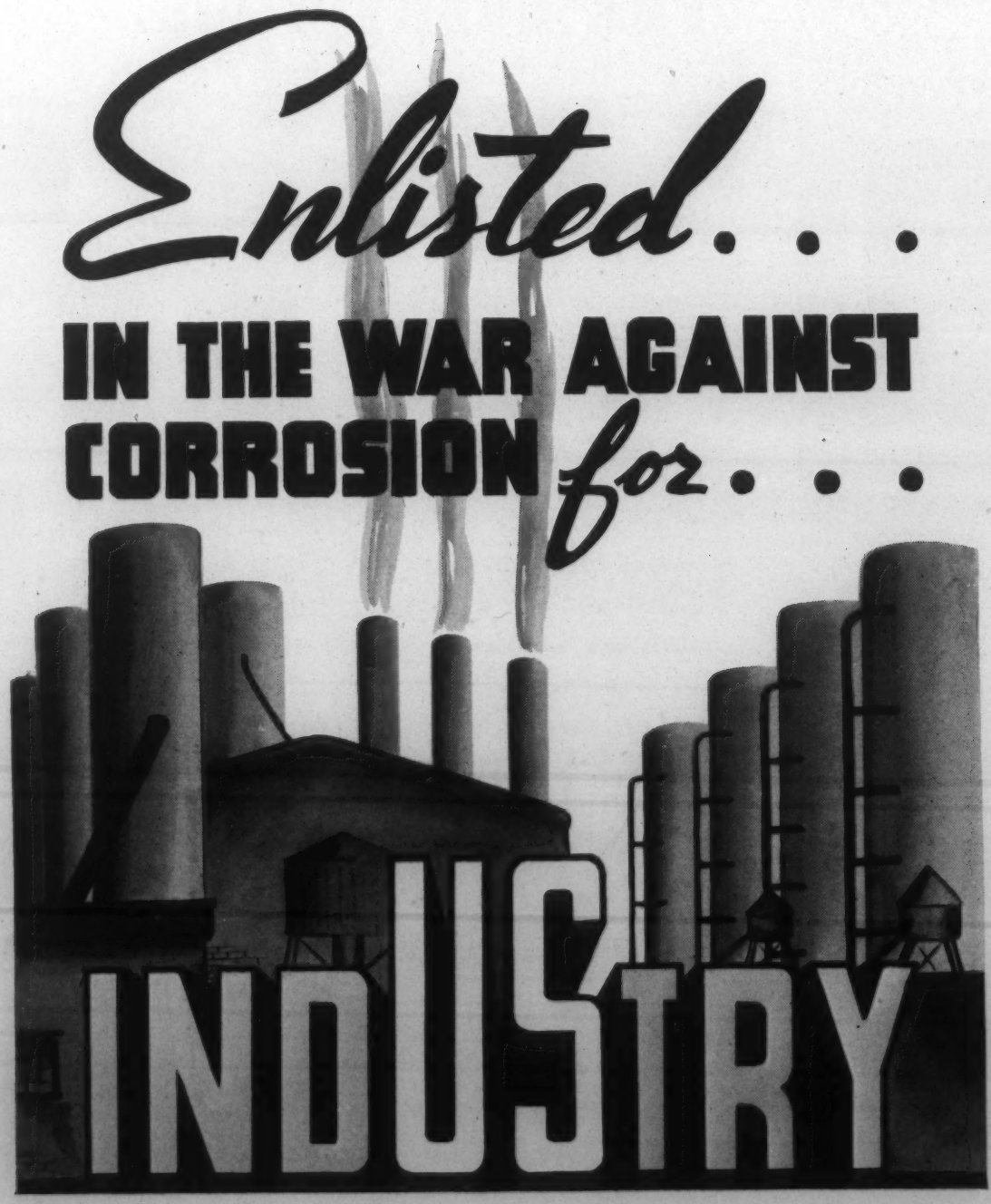
Among the more widely employed nonferrous alloys for condensers, usually tube and shell type, is Admiralty metal—70% Cu, 29 Zn and 1 Sn. Failure of Admiralty tubing on the water side is manifested by selective attack and complete penetration, commonly known as "dezincification" or plug type corrosion. This is characterized by deposition of copper plugs, which become galvanically active.

Small amounts of "dezincification" suppressors, notably arsenic, antimony or phosphorus, are effective. The higher-copper alloys, such as 85% Cu, 15 Zn, are considerably less susceptive to plug type corrosion.

As regards the petroleum industry, however, the "85-15" has definite limitations of use against hydrogen sulphide and organic sulphur compounds found in petroleum distillates, in view of the chemical affinity between these and copper. In the use of either alloy, ample consideration must be given to the varying types of water and corrosives in the condensibles.

Within recent years, cupro-nickel tube material (70% Co, 30 Ni with same additions) has found increasing use in the petroleum industry. Service data on this alloy vary from good to bad, depending again on service requirements. The 70-30 alloy, however, is a definite improvement over Admiralty in service applications where the latter fails by dezincification or impingement attack.

Monel metal (67% Ni, 30 Cu, 3 Fe) for condenser tubes is used in the petroleum industry to a limited extent, not so much against corrosion on the water side as against the specific corrosiveness of certain



TESTING *Standard's* PRODUCTS FOR YOUR PROTECTION

Southwark-Tate-Emery Universal Testing Machine in the testing laboratory of Standard Steel Works, Burnham, Penna.

The materials going into Standard's forgings and castings are under the constant supervision of trained metallurgists. Their job is to safeguard the quality built into every part delivered to our customers.

A complete, modern testing laboratory is constantly engaged in research and routine tests for your protection.

Add trained shop personnel and up-to-date manufacturing equipment and you have the story behind the satisfactory service of materials made by Standard.

STANDARD STEEL WORKS

THE BALDWIN GROUP

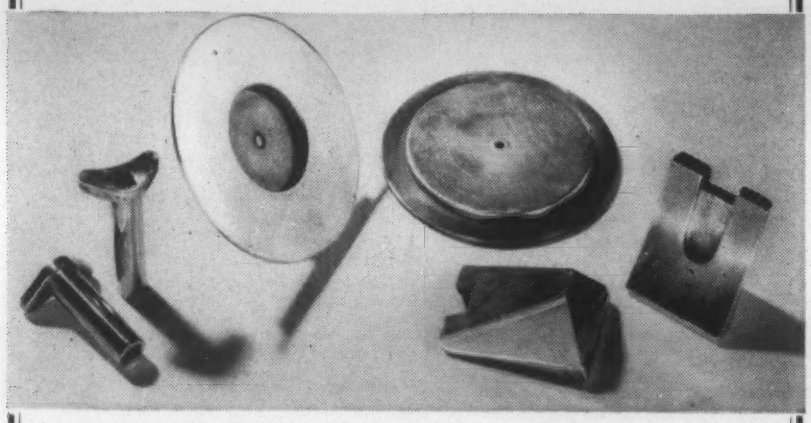
Division of THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

Other Members of the Baldwin Group • THE BALDWIN LOCOMOTIVE WORKS
BALDWIN SOUTHWARK DIVISION • THE PELTON WATER WHEEL COMPANY
BALDWIN DE LA VERGNE SALES CORP. • THE WHITCOMB LOCOMOTIVE COMPANY
THE MIDVALE COMPANY • CRAMP BRASS AND IRON FOUNDRIES DIVISION

POWDER METALLURGY MACHINE PARTS

POWDER METALLURGY INC. offers fast and economic manufacture of complicated parts on contract basis. "POMET," exclusively in our products, is made in many analyses to meet your present specifications of brass and bronze, aluminum and ferrous alloys.

Send blueprints and specifications for quotation



Typical small brass parts now being manufactured by us of POMET—with very close tolerances.

POWDER METALLURGY INCORPORATED
42-41 CRESCENT STREET LONG ISLAND CITY, N. Y.

ELEPHANT BRAND PHOSPHOR BRONZE

RODS • SHEETS • WIRE • ROPE • INGOTS • CASTINGS • BUSHINGS •

Tough!
Strong!
Elastic!
Resistant
to corrosion!

The Phosphor Bronze Smelting Company
2208 Washington Ave., Phila., Pa.

ORIGINAL MANUFACTURERS OF PHOSPHOR BRONZE in U.S.A.
• *Established 1874* •

vapors and liquids. The higher cost of the alloy (approximately 4½ times that of Admiralty) has prevented its wide use and a more comprehensive study of its application possibilities.

An extensive study of corrosion of various non-ferrous alloys used in shell and tube condensers by the petroleum industry is made by JAMES T. KEMP (Corrosion of Copper-Alloy Condenser Tubes by Water," *Ibid.*, 9 pp.). The life of Admiralty metal is taken as a yard stick in comparing the service life of other non-ferrous tube materials.

Muntz metal (70% Cu, 30 Zn) is not recommended for water-cooled heat-exchangers; neither is deoxidized copper nor arsenical copper recommended against salt or brackish water; red brass (85% Cu, 15 Zn) or a copper-silicon alloy is preferable.

Cupro-nickel resists either fresh or brackish water. Although aluminum brass resists salt water better than Admiralty, in fresh water service no notable improvement is observed.

Tube life, regardless of the alloy employed, is governed to a marked extent by the design of the equipment. Savings in equipment have been effected by a trend toward open-tube arrangements in steam-condenser design. AAA (3)

Automotive Bearings — Metals, Design and Lubrication

"ENGINE DESIGN VS. ENGINE LUBRICATION." R. J. S. PIGOTT (Gulf Research & Development Co.) *S. A. E. Journal*, Vol. 48, May 1941, Trans. pp. 165-173. Discussion pp. 173-176. Review.

Much bearing trouble is due to improper cooling of oil and insufficient oil flow to the bearings, resulting in high oil and bearing temperatures. Where bearings are made of certain alloys, such as cadmium-silver, which are catalytic to oil breakdown, the trouble is aggravated. With general rise in operating temperatures, effect on oil of metals used in engine construction is of interest.

The author rates the common bearing metals in the order of merit—tin, aluminum, iron, copper, lead and cadmium. The state of the metal—whether as permanent surfaces or as small particles—is also important. Tin seems to be an anti-catalyst. Corroded bearings were not heard of before cadmium-silver and copper-lead were used in automotive engines.

The effect of iron in the engine changes with conditions. Tests during breaking-in of engines showed that during the first few hours considerable colloidal iron was brought down, which was affecting the oil rapidly. As conditioning proceeded, less and less iron came down and fresh surfaces began to form some protective films.

Experiments showed that the less copper in contact with oil, the better. The period after overhaul is important; the work done and solvent cleaning that follows expose much more clean metal than is present in a new engine, and the oil deteriorates at an increased rate. Misalinement causes trouble by reducing ultimate load-carrying capacity.

Copper-lead bearings should be given considerably more clearance than babbitt. Line-reaming copper-lead bearings can give trouble by raising roughness and leaving the shell surface most susceptible to accelerated attack. When copper-lead bearings are fitted tightly and idled to run-in, local high-temperature spots develop, because of high temperature and very low oil flow. While this starts corrosion, in many of these cases actual lead sweating may occur.

The author is convinced that few new alloy bearings are needed in automotive engines and that, with proper cooling, oil system, and bearing design, babbitt would be the most satisfactory alloy for 90% of the cases. MS (3)

3a. Ferrous

Welded Stainless for Chemicals

"WELDED STAINLESS STEEL MAKES CORROSION RESISTANT CHEMICAL PLANT." *Sheet Metal Inds.*, Vol. 15, Mar. 1941, pp. 392, 394, 396, 398. Practical.

Welded stainless steel meets the 4 requirements of chemical equipment: strength, tight joints, corrosion resistance, and ease of cleaning. For nitric acid, 15-30% Cr steel or 18-8 is usually suitable. The 18-8 or higher chromium steel is best if other chemicals such as sulphuric acid are present.

The 18-8 steel with columbium or titanium is suitable for piping and pumps for nitreous acid and for fuming sulphuric. The 18-8 + 3% Mo steel is often used for digesters and other equipment handling hot sulphuric acid, as well as for equipment for cold phosphoric up to 50%. Oxyacetylene is particularly good for welding this type.

Steels of the 18-8 type are widely used for handling salt solutions and alkalies. Boric acid plants usually use either 18-8 or 14% Cr steel, although iron-silicon alloys can be used if the purity of the product is not so important. Welded stainless steel piping is used for hot sulphite liquors and vapors in sulphite pulp mills. Either 22-12, 18-8, or 18-8 + 3% Mo steel is used. The

a.c.f.
Parlor Coaches

Built of

N-A-X
High Tensile

DUCTILITY
ITS INHERENTLY FINER GRAIN
MAKES ALL THE DIFFERENCE
STRENGTH

. . . this equipment is lighter, safer, stronger, and has unusually high resistance to shocks and stresses—empty or loaded

Fabricator and user alike appreciate the important economics of building rolling equipment of N-A-X HIGH TENSILE. For here is a low alloy steel having high yield point, high ultimate strength, excellent welding characteristics and greatly increased resistance to both corrosion and abrasion. Because it is unusually ductile, it can be cold formed readily, in most cases without change in shop practice.

A factor of particular importance to operators is the *very high* resistance N-A-X HIGH TENSILE has to impact and fatigue, at both normal as well as at sub-zero temperatures. This means that equipment built of N-A-X HIGH TENSILE will operate at high efficiency in all kinds of weather conditions with less maintenance and replacement cost.

Take advantage of these unusual properties of N-A-X HIGH TENSILE for *your* products. A Great Lakes engineer who has experience in the use of this steel in all types of applications will be glad to show you how you can use N-A-X HIGH TENSILE to advantage. Wire, write, or telephone for one.

LIST OF PRODUCTS

Hot Rolled Strip (down to 1 inch wide) . . . Hot Rolled Strip Sheets (up to 91 inches wide) . . . Spring Steel (carbon and alloy) . . . Merchant Bars . . . Forging Bars . . . Automobile Bumper Sections . . . Bar Mill Sections . . . N-A-X HIGH TENSILE Bars, Shapes, Sheets, Billets . . . Sheet Bars . . . Hot and Cold Rolled Sheets . . . Michigan Metal for Vitreous Enameling . . . Deep Drawing Quality (in all grades, widths up to 91 inches) . . . Stran-Steel Metal Framing for Residential and Commercial Construction.

GREAT LAKES STEEL CORPORATION—DETROIT, MICHIGAN

Sales Offices in Principal Cities

division of NATIONAL STEEL

NATIONAL STEEL CORPORATION

Executive Offices, Pittsburgh, Pa.

18-8 steel is generally satisfactory in the dye industry and for resistance to organic compounds, but acetic acid if over 56% requires 18-8 + 3% Mo.

Steels of the 11-15% Cr type should be annealed (1250°-1300°F. or a blowpipe anneal) for best properties. Grain growth should be carefully guarded against in the 15-18% Cr steels; the ductility is improved by annealing. The welding rod for this group can be either of the same composition as the base, or 18-8. Steel of the 24-30% Cr type can be welded with rod of the same analysis; it is suitable for high temperature work although it is not very resistant to severe mechanical treatment at room temperature.

Such steels as 25-12 and 25-20, which are used for higher temperature work, have a high coefficient of expansion and low conductivity, so the rightward method of welding is preferred. Generous applications of flux are needed. Grain growth cannot be removed by subsequent annealing. If 18-8 is not heat treated after welding, it should be stabilized with titanium or columbium or the carbon should be under 0.4%. A neutral oxyacetylene flame is recommended.

JZB (3a)

Cathodic Protection of Condensers

"Cathodic Protection of Open Tank Condensers." N. A. Miller. *Am. Petroleum Inst.*, Paper presented at Mid-Year Meeting, Tulsa, May 21, 1941. 6 pp.

Although cathodic protection of pipe lines has been successfully used for a number of years and a wealth of information has appeared in the literature, published data on the similar application of the cathodic protective principle to open tank condensers have been meager. The principles, however, have been economically applied to ships' bottoms and also to shell and tube coolers, in some instances using zinc anodes—in others, applying external potential energy for protection.

The author cites successful applications of externally applied potentials to open box type coolers or condensers. Prior to the adoption of cathodic protection, replacements of condenser coils, because of excessive scaling and resultant corrosion, were frequent. In addition, because of scale formation, heat-transfer-efficiency was lowered.

Cathodic protection appreciably reduces costly coil replacements, increases heat-transfer-efficiency and renders the "temporary hardness" salts of the cooling water more easily removed from the tube external walls.

Information, illustrations and cost data on a typical oil refinery installation are given. The total annual cost, including the electrical unit, amortization and maintenance, is estimated at $260/yr., as compared to previous condenser coil losses of approximately $1,000/yr. [*This paper will undoubtedly stimulate thought, interest and further research activities among industries where corrosion on the water-side of condensers is a major operating problem.—A.A.A.*] AAA (3a)

Cast Iron Panels for Radiant Heating of Buildings

"Radiant Heating with Cast Iron Panels." F. W. Hutchinson. *Heating, Piping & Air Conditioning*, Vol. 13, Apr. 1941, pp. 231-234. Descriptive.

The effectiveness of any system of heating or cooling buildings with low-temperature radiant energy is a function only of the area and temperature of the panel surface. Selection of a particular type of panel is based on considerations of relative responsiveness to control, flexibility of operation, and heat-transfer-ability of the panel. Maintenance experience, amenability to repair, structural requirements, etc. are also factors.

There has been one method of panel construction, widely used in Europe, that has received but scant attention in the United States. This method employs cast iron plates and differs strikingly from the sinuous embedded coil and electric fabric systems familiar in this country.

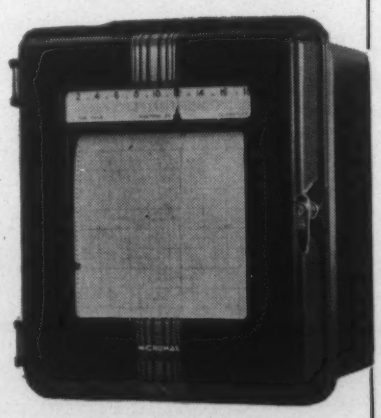
The cast iron panel is manufactured complete in standard sections ready for assembly and installation by the heating contractor. The panel surface receives heat transferred from cast iron waterways and is itself either an integral part of the waterway casting or a steel plate affixed to that casting.

The units are attached to or recessed into the ceiling or wall, but do not become an integral part of the room structure. For this reason they are often referred to as "applied" rather than "embedded" panels. Unfortunately, the units are not invisible.

In practice the panel manufacturer recommends use of the cast iron panels at higher temperatures (water above 160° F., or steam) than those common with sinuous coils. The higher surface temperature reduces by about one-half the necessary panel area. However, careful analysis of panel position is necessary, to be certain of uniformity of heating.

There are more than 100 of such cast-iron panel installations in Italy alone, and

ALWAYS WORKING ...but never weary



In helping to meet today's commercial and defense demands, many a Leeds & Northrup "Micromax" Recorder is denied all holidays—works 24 hours to a shift, 7 days a week. For such constant service, Leeds & Northrup demands electrical contacts of high accuracy. And *gets* them—in Wilco materials. And just as Wilco meets these exacting requirements for electrical contacts—so do Wilco's Thermometals (thermostatic bimetals) provide dependability for temperature control—or reaction from temperature changes.

Whether your orders are large or small, they are personally supervised by an executive of The H. A. Wilson Co. And that means shipments that are *right*—every time! For full information, write: The H. A. Wilson Co., 105 Chestnut St., Newark, N. J. *Branches:* Chicago and Detroit.

Now more than ever Personal Attention Counts

WILCO THE H. A. WILSON CO.

"CHECK IN AT DeWITT OPERATED HOTELS"

In Cleveland
HOTEL HOLLENDEN
In Columbus
THE NEIL HOUSE
In Akron
THE MAYFLOWER
In Lancaster, O.
HOTEL LANCASTER
In Corning, N. Y.
BARON STEUBEN HOTEL

DeWITT OPERATED HOTELS

THE HOTELS THAT CHECK WITH EVERY TRAVEL STANDARD

THEODORE DeWITT, President — R. F. MARSH, V. P. & Gen. Mgr.

Vitality

Our enlarged plant will be completed a month ahead of schedule and full capacity operation is to start July 7th. A second addition 140 ft. by 40 ft. will be completed August 1st.

To say that we would not accept new business would be foolish—to say that we can fill all orders with equal facility would be wishful thinking. We do say however, that Superior Tube Company to the limit of its capacity, is ready to take care of its obligations in the order of their relative importance.

H. Gabel

SUPERIOR TUBE CO.

["*Small Tubing is our only business, and we know it.*"]

NORRISTOWN, PENNSYLVANIA

Tubing from 5/8" OD down . . . **SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless. BRAWN Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.**

"FOR FINE SMALL TUBING"

at least 500 in all of Europe. It is emphasized that these panels are not competitive with sinuous coil or electric fabric in the field of low-temperature (90°-100° F.) ceiling panels. FPP (3a)

Automotive Metal Problems

"Mirrors of Motordom." A. H. Allen (Staff) *Steel*, Vol. 108, Apr. 21, 1941, pp. 35-36, 42. Descriptive review.

With priorities on nickel-bearing steels, car manufacturers are giving attention to reduction of the amount of nickel required in electroplating. The present electrodeposit usually comprises a base plate of about 0.001 in. copper, 0.001 in. nickel and a flash plate of at least 0.000015 in. chromium. It is planned to cut the nickel thickness to about 0.0003 in., and increase the copper to about 0.0017 in., with the same chromium flash.

Extra buffing of the copper plate is required. Complete elimination of nickel does not seem feasible because of the adverse color effect that copper has on the chromium layer, and because any pitting or peeling of chromium bares the copper; this does not happen when a nickel interlayer is used. If nickel should not be available, plating may be eliminated except for the barest essentials.

Manufacturers of cars and parts are much interested in the so-called "twin-six" high-speed steel. The basic type contains 6% Mo, 6 W, 4 Cr, 1.5 V and 0.85 C, and essentially a compromise between the Mo-Max and the 18-4-1 and 18-4-2 types of high-speed steels. It is denser than the former and easier to heat treat in the average small shop, while showing results equal to the latter at 9½c a lb. less cost. An important feature is that it can be hardened without using salt-baths or controlled-atmosphere furnaces.

The Ford Motor Co. is experimenting with austenitic rings in the top section of cylinder walls. The heat concentration at the top inch of the cylinder bore is deleterious to liners, so it was decided to try shrinking in place a ⅛-in. thick and 1-in. deep cast alloy iron ring, to provide heat, corrosion, and wear resistance.

Various compositions have been tried, including Ni-Resist, high-chromium iron, copper-manganese alloy, etc. It is essential that the material be austenitic to obtain corrosion resistance, secure fit and avoid growth from repeated heating and cooling. Similar rings have been tried in England and Italy previously. MS (3a)

VULCOID

HERE MAY BE THE ANSWER TO YOUR "WHAT MATERIAL?" PROBLEM

CAUTION should be used in selecting substitute materials . . . such as plastics for metals . . . to make certain that shortages will not also develop in the substitute selected.

VULCOID is a NON-metallic . . . a laminated plastic fibre made in sheets, rods and tubes . . . readily fabricated on standard metal working machinery. It is tough . . . moisture resistant . . . heat resistant . . . and oil resistant. It has high electrical insulating properties and is exceptionally resistant to carbon deposits from electrical arcs. VULCOID is approved by the Underwriters' Laboratory for the insulation of current carrying parts.

VULCOID is a product of Continental-Diamond Laboratory research. Its development has progressed over a number of years. Its availability at this time is especially opportune because in its production it requires considerably less of present hard-to-get raw materials than do many other NON-metallic products.

VULCOID may be the answer to your "What Material?" problem. Let us send you Technical Data Bulletin BC-24.

Properties of VULCOID

¼" THICK MATERIAL

Specific gravity 1.35
Tensile Strength 7,000/11,000 PSI
Flexural Strength 16,000/20,000 PSI
Shearing Strength 10,000/12,000 PSI
Compression Strength 36,000 PSI
Moisture absorption 4% to 8%.
(% weight gain in 24 hours immersion)
Dielectric Strength 250/350 volts per mil.

Continental-Diamond FIBRE COMPANY

"Manufacturers of Laminated Plastics Since 1911"

NEWARK • DELAWARE

3b. Non-Ferrous

Low-Cobalt "Stellites"

Lowering the Cobalt Content in Welded-On Hard Facing Alloys ("Die Verminderung des Kobaltgehaltes in Aufschweisslegierungen") M. Schmidt, W. Lamarche & E. Kauhausen. *Archiv Eisenhüttenw.*, Vol. 14, Jan. 1941, pp. 357-362. Original research.

It is stated that in the cobalt-chromium (Stellite type) alloys used for hard facings on valves, etc., and ordinarily containing about 1.25 C, 65 Co, 28 Cr and 4% W, the structure should be face-centered cubic to give the desired properties of hot hardness, wear and corrosion resistance, and weldability.

When the cobalt content was lowered to 27%, the structure remained face-centered cubic, but the hot hardness diminished appreciably. Adding nickel stabilized the face-centered cubic structure at even lower cobalt contents, but again the hot hardness and also the room temperature hardness were lowered materially.

However upon the addition of 4-5% Mo satisfactory hot hardness was obtained in an alloy of only 19% Co. An alloy of 1.59 C, 2.33 Si, 0.64 Mn, 19.25 Co, 29.9 Cr, 4.55 Mo and 3.96% W gave good results. In general, it is stated that the addition of 4-5% Mo makes possible a lowering of the cobalt content of the "Stellite type" alloys of over 40%. SE (3b)

Lead-Tellurium Alloys

Work Hardening and Precipitation Hardening of Lead-Tellurium Alloys ("Verfestigung und Aushärtung der Blei-Tellur-Legierungen") Wilhelm Hofmann & Heinrich Hanemann. *Z. Metallkunde*, Vol. 33, Feb. 1941, pp. 62-63. Original research.

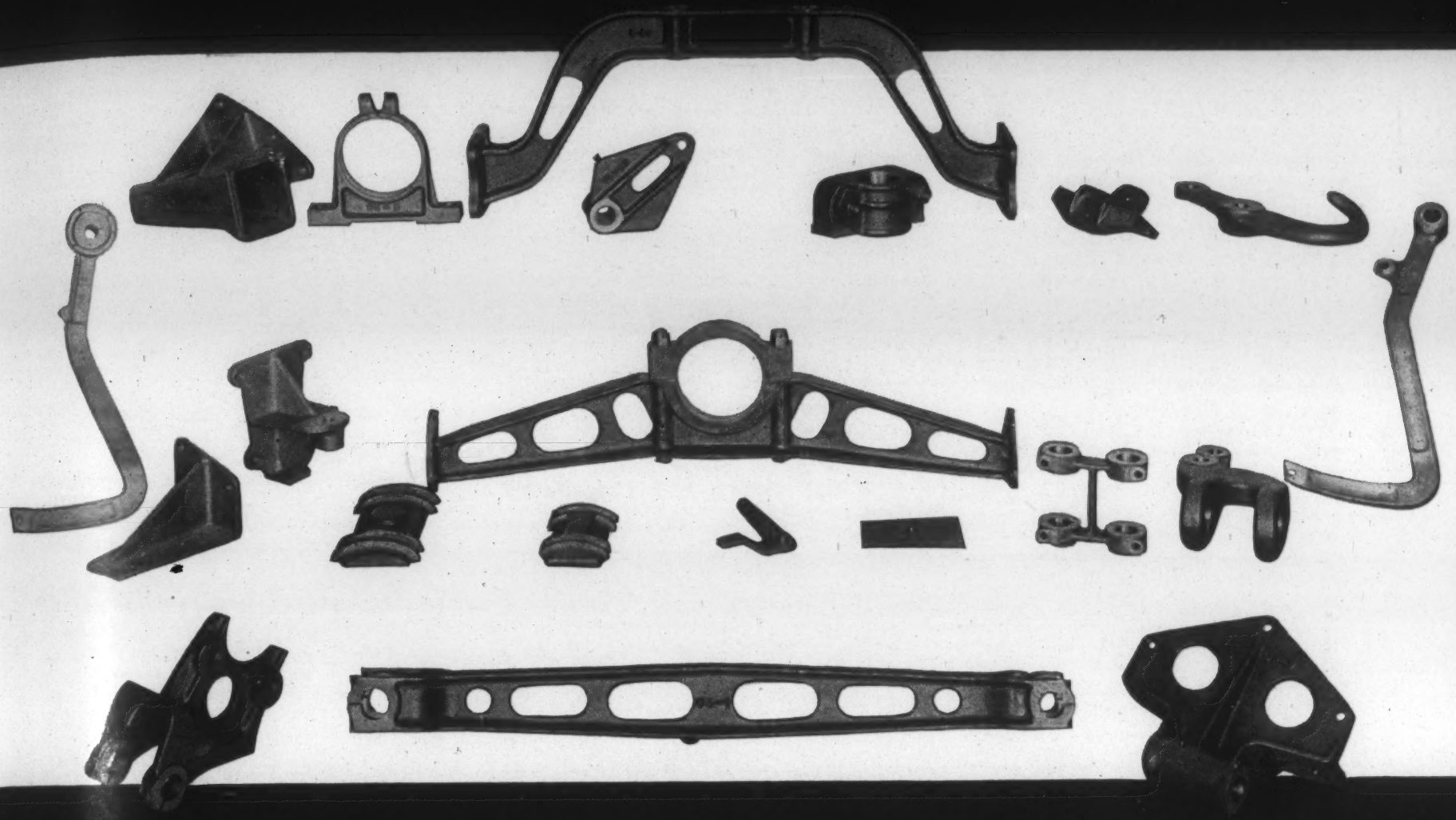
The lead-tellurium alloys were developed in England several years ago. Their susceptibility to work hardening and the retention of this enhanced hardness at room temperatures are the most conspicuous properties.

The authors studied the effect of 0.1% Te in 99.99% pure lead. Work hardening takes place with up to 80% cold rolling. Then the alloy softens partly in further rolling, and completely on storing.

At small deformations, considerable precipitation hardening effects are discovered At 75% deformation and above, softening due to recrystallization occurs.

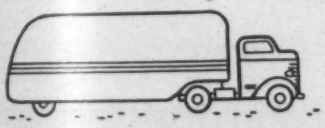
Thus, the "stability against recrystallization at room temperatures" appears in a new light and an analogy to precipitation-

WHERE WEIGHT MEANS EXPENSE



STEEL CASTINGS SAVE MONEY!

LIGHTER, STRONGER PARTS...



Every pound saved in building a motor truck makes room for another pound of pay load. And smart truck operators make their profit on pay load, not on dead weight.

For that reason truck manufacturers are turning to steel castings for parts that are lighter in weight, without the slightest sacrifice of strength and long life.

See how weight has been saved in the alloy steel truck castings illustrated above. Metal is scientifically distributed—no excess where it is not needed. Yet there is ample strength and rigidity, true and permanent alignment, resistance to fatigue.

And remember this—thin sections are no problem to the modern steel foundry.

All of these advantages, plus big savings in assembly and finishing costs, and a wide selection of mechanical properties, are available to you in improving and modernizing your products.

For both product improvement and cost saving, use more steel castings. Your own foundryman will work with you, or you may write for information, without obligation, to Steel Founders' Society of America, 920 Midland Building, Cleveland, Ohio.

FOLLOW THE EXAMPLE OF THE MOTOR TRUCK BUILDER—MODERNIZE YOUR PRODUCT WITH

STEEL CASTINGS

hardening lead-calcium and lead-antimony alloys is established. The latter are only stable in the fully precipitation-hardened state.

In contradistinction to the lead-antimony alloys, the lead-tellurium alloys extruded at elevated temperatures do not possess a combination of high stiffness with high fatigue strength. The high fatigue strength of lead-tellurium alloys was confirmed in the DVL fatigue bending machine. Its favorable endurance properties combined with a certain softness indicate the value of lead-tellurium for cable sheath application. EF (3b)

Aluminum for Food Containers

SUITABILITY OF ALUMINUM AS COMPARED WITH OTHER MATERIALS FOR THE MANUFACTURE OF PRESERVING CANS ("Eignung von Aluminium im Vergleich zu sonstigen Werkstoffen zur Herstellungvon Konservendosen") A Symposium, *Aluminium*, Vol. 23, Feb. 1941, pp. 63-77.

The development of the aluminum container, reasons for the change (in Germany) from the formerly used tin cans, and the special requirements, surface protection and the manufacture of extruded aluminum cans were discussed at a special meeting on aluminum cans in Germany. [Since Germany has plenty of aluminum, a shift from tin plate to the light metal for this purpose is strategically feasible; in America at present no one is sensibly advocating such an extension of aluminum application. However, this is a use for aluminum that may be of interest when the emergency has passed, and any reasonable market will be worth developing.—F.P.P.]

Tin is becoming increasingly scarce in Germany. As regards chemical attack, aluminum is said to be equal and (for certain foods) even superior to tin plate. Its lightness is of great advantage in shipping. The cans can be opened easily and have sufficient strength against pressure and impact.

Protection against oxygen in the fruit juices is easily and safely obtained by anodizing, or applying certain lacquers, which adhere even better on aluminum than on tin plate because of the inherently greater roughness of aluminum sheets. Extruded cans have the particular advantage of having no seams except for the lid, the sidewalls and bottom being of one piece.

Experiments over a 3-yr. period by the (German) State Health Department showed that bright bare aluminum cans can be used without hesitation for meats, sausage, fats, milk, peas and asparagus; for other vegetables and fruits, the inside should be protected. Fish preserves in oil can also be packed in bare aluminum cans, but other fish preserves, which are strongly acid, require inner protection. Standardization of aluminum cans is being considered in Germany Ha (3b)

Micro-Hardness of Bearing Metals

MICRO-HARDNESS TESTING OF CONSTITUENTS IN BEARING METALS ("Mikrohärte-Messungen an Gefügebestandteilen von Lagermetallen") ALFRED RAPP & HEINRICH HANEMANN. *Z. Metallkunde*, Vol. 33, Feb. 1941, pp. 64-67. Original.

The previously announced Hanemann micro-hardness tester (see METALS AND ALLOYS, Vol. 12, July 1940, p. 108) built by Zeiss was employed for testing the hard micro-constitutents of different bearing metals over a wide load range of 2-21 g. The tests were made on lead-, aluminum- and zinc-base bearing alloys, and 15 characteristic micro-structures showing the diamond indentations are reproduced and discussed fully.

The hardest constituents in bearing metals are the epsilon and eta phases in copper-tin alloys, which have micro-hardnesses of over 400 "Brinell." Next in hardness come the dark crystals in a lead-base bearing alloy known as "Thermit" (71% Pb, 22 Sb, 4 Sn, 2 Ni, 0.45 Cu, 0.5 As, 0.05 P) with values of 262 and 308, and Cu_2Sb with 278.

Arsenic and the arsenic-antimony solid solution possess the same hardness, *i.e.* 176. The difference between antimony and SbSn is but small, the hardnesses being 114 and 107, respectively. The second lowest micro-hardness, 93, was found with Pb_2Ca as it occurs in the well-known German "Bahnmetall" bearing alloy (0.03-0.04% Li, 0.58-0.62 Na, 0.60-0.73 Ca, 0.1-0.2 Al, balance lead.

The softest "hard bearing constituent" is PbTe (46 units), which occurs in lead alloyed with 0.43% Te. The high-lead base bearing alloys show, naturally, a very soft matrix. The great difference in hardness between the hard constituents and the lead solid solution in the "Thermit" alloy is conspicuous. In the case of "Bahnmetall," the primary crystal is only twice as hard as the matrix, whose hardness is considerably higher than that of "Thermit".

The matrix hardnesses of the 2 aluminum base bearing alloys are about the same, *i.e.* 73 and 87. (The analyses of these alloys is not given except that they contain 3-5% Pb.) Regarding the constituents of the zinc-base bearing alloys, the

OFHC

OXYGEN FREE HIGH CONDUCTIVITY

A Superior Copper

FOR ALL PURPOSES

OFHC Copper conforms to the A.S.T.M. Specification for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact.

OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

OFHC
REG. U.S. PAT. OFF.

THE SCOMET ENGINEERING CO.
420 Lexington Avenue New York, N.Y.
Formerly
U. S. Metals Refining Co.'s Oxygen-free Copper Dept.

Official Record*

ARMAMENT PRODUCTION POLICIES

Questions — Answers

for

INDUSTRIAL EXECUTIVES AND ENGINEERS

*A RECORD OF A FORUM
held in the Engineering Societies Auditorium
BY THE NEW YORK POST OF THE
ARMY ORDNANCE ASSOCIATION

- What are the Various Forms of Government Bids?
- What Tax Provisions Apply on Government Contracts?
- How Does the Government Aid in Procuring Additional Plant Facilities?
- How May Financial Assistance Be Obtained?
- What are the Types of Government Contracts?
- What are the Labor Provisions in Government Contracts?

Nowhere Else Can This Authoritative Information Be Obtained So Quickly!

Price $1.00

REINHOLD PUBLISHING CORPORATION
330 West Forty-Second St., New York, U. S. A.

solid solution high in aluminum tests only 48, as against a micro-hardness of 103-129 for all the other crystal phases. The ternary eutectic is relatively hard. The soft aluminum-solid solution appears to affect the hardness but slightly. EF (3b)

Strong Aluminum Alloys Containing Vanadium

PRECIPITATION-HARDENABLE ALUMINUM-ZINC-MAGNESIUM WROUGHT ALLOYS ("Ueber aushärtbare Aluminium-Zink-Magnesium-Knetlegierungen") W. BUNGARDT & G. SCHAITBERGER. *Luftfahrtforschung*, Vol. 18, Feb. 28, 1941, pp. 26-31. Original research.

Experiments aiming at the development of a precipitation-hardening, commercial aluminum-zinc-magnesium wrought alloy of higher strength, better corrosion resistance, and stress-corrosion immunity after water quenching from 850°F. and room temperature aging, led to an aluminum alloy containing 4.5% Zn, 3.5 Mg, 0.3 Mn, 0.3 Fe, 0.2 Si and additions of vanadium and copper.

More uniform shop results are obtained with water quenched than with air-cooled alloys. Thus, preliminary tests restricted the maximum zinc content to 5%. As the alloy should lend itself to forging and extrusion, the maximum manganese content had to be lowered to 0.4-0.5%. The iron and silicon content should permit the use of commercial aluminum of 99.5% purity.

The effect of small additions of vanadium and copper was studied most thoroughly in regard to strength and ductility, stress-corrosion and general corrosion resistance in relation to different heat treatments (water *vs.* air quench). Vanadium additions as low as 0.05% refine the grain appreciably, but vanadium aluminide crystals appear near 0.25% V.

A series of aluminum alloys with constant zinc, magnesium, manganese, silicon and iron contents and with vanadium and copper contents varying from 0.05% to 0.25% and from 0.01-0.76%, respectively, show that the precipitation hardening effects and elongation values drop considerably on changing from water quenching to air cooling from 850°F.

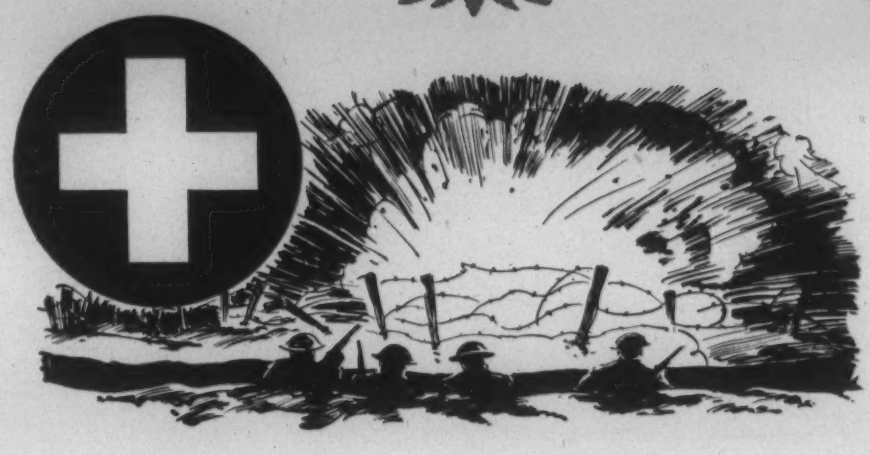
By raising vanadium from 0.05% to 0.1% a considerable gain of strength is obtained. Elongation drops slightly and tensile strength and yield point increase notably on increasing the copper from 0.1% to 0.65%.

The stress-corrosion resistance was tested in 3% NaCl solution using 10% cold rolled looped strip samples. A marked improvement is obtained by adding 0.1% V, but higher concentrations have no further beneficial effect on the stress-corrosion resistance. Complete immunity against this defect is secured by adding 0.1% V + 0.1% Cu.

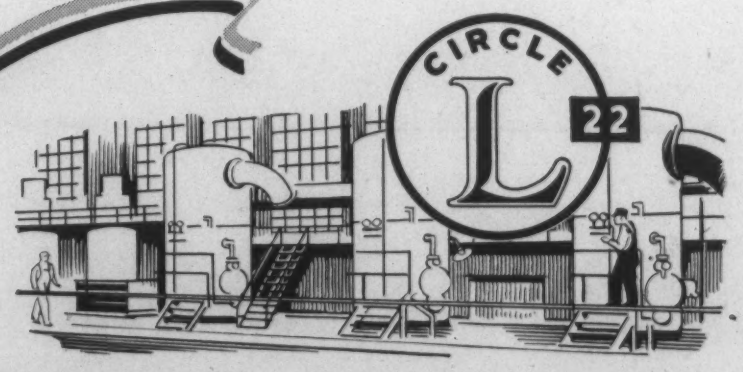
The tendency of water-quenched, age-hardened aluminum-zinc-magnesium alloys toward stress-corrosion breakdown can thus be banished by small additions of vanadium + copper. The general corrosion resistance was tested progressively during 28 days by loss of strength and ductility. Rising vanadium additions lower the corrosion resistance of both water-quenched and air-cooled alloys, but this impairment shows up only *above* 0.1% V. Even at that, the vanadium-containing alloys are better than the presently used, not-cladded aluminum-copper-magnesium alloys.

Copper has no effect up to 0.3%, but the general corrosion stability falls off with time, due to pitting, above 0.3% Cu. EF (3b)

SYMBOLS of DEFENSE



DECISIVE battlefields of World War I knew well the Yellow Cross of the 33rd or "Prairie" Division. On the ridges of the Meuse-Argonne and on the bitterly contested ground of Saint Mihiel, it proved to be the insignia of first class fighting men. At the Bois de Forges, the "Prairie" Division broke through strong enemy positions to protect the flank of a successful American attack. 6,864 casualties were suffered in ninety-eight days of front line service. Today, the "Yellow Cross of the Prairies" is still proudly worn by the men of the Illinois National Guard. They are now in training at Camp Forrest, Tennessee, preparing to defend America against any possible adventure of aggressors or threat to its security.



"DECISIVE BATTLES" in many a defense industry are those fought against corrosion of vital equipment. In these combats, the symbol of Lebanon's Circle L 22 has become known as the insignia of sure protection. This 18 and 8 stainless alloy is used to resist acetic acid, alkaline liquors, ferrous sulphate, sodium sulphate, hydrogen sulphide at normal temperatures. Circle L 22 meets U. S. Navy requirements when a carbon maximum of .07 is specified. This low carbon content is made possible by melting in Lebanon's induction furnaces.

LEBANON STEEL FOUNDRY • LEBANON, PA.

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON *Stainless and Special Alloy* STEEL CASTINGS

Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. X-ray and Magnetic Inspection. Spectrographic and Photoelastic Analysis. Corrosion and Wear-Testing. Examination of Coatings, Surface Measurements. Metallographic Structure and Constitution.

New X-ray Inspection Technique

"A New Use for X-rays in Industry." R. C. Woods & L. P. Kenna. *Electronics*, Vol. 14, Apr. 1941, pp. 29-31, 89, 90, 91. Descriptive.

The ionization of air by means of X-rays has been applied in an unusual manner to the routine inspection of soldered joints in the interior of table knives in the plant of Oneida, Ltd., Oneida, N. Y. Electric currents of the order of 10^{-9} amp. or 1 milli-microamp. are utilized. The control quantities are so small that complete elimination of all X-ray radiation and electrostatic fields is necessary to proper operation.

The problem involved inspection of the soldered bonds between blades and hollow handles in table knives. In a very small percentage of cases, some solder escapes and leaves an imperfect joint. Such a condition is instantly detected by the method described and can be corrected immediately.

A method was first devised for visual fluoroscopic inspection of knife assemblies passing through an X-ray beam on a conveyor belt. Then, experimental work was begun on an apparatus for automatic selection and rejection of good and bad knives.

A photocell activated by the fluoroscopic image was first tried, but changes in brilliancy were found insufficient for satisfactory operation. Therefore, recourse was made to the method of gas ionization by X-rays.

A narrow pencil of X-rays is directed at the knife handle area where inspection is desired. The ionization chamber is situated immediately behind the knife, so that when sufficient lead is present in the joint, X-rays are completely blocked and do not reach the chamber at all.

On the other hand, wherever solder is absent, or porous, X-rays pass through into the chamber and allow a current to pass between charged plates. Since the magnitude of this current depends on the intensity of X-rays received by the chamber, and this quantity in turn is regulated by the amount of solder in the handle, it then follows that measurement of the ionization current will indicate the size of defect in the knife.

From here on, the problem is purely one of amplification so that changes in current can be made to actuate a galvanometer relay for operation of the rejection circuit.

In operation, after the knife has remained in the exact center of the chamber for

Did You Get Your Copy?

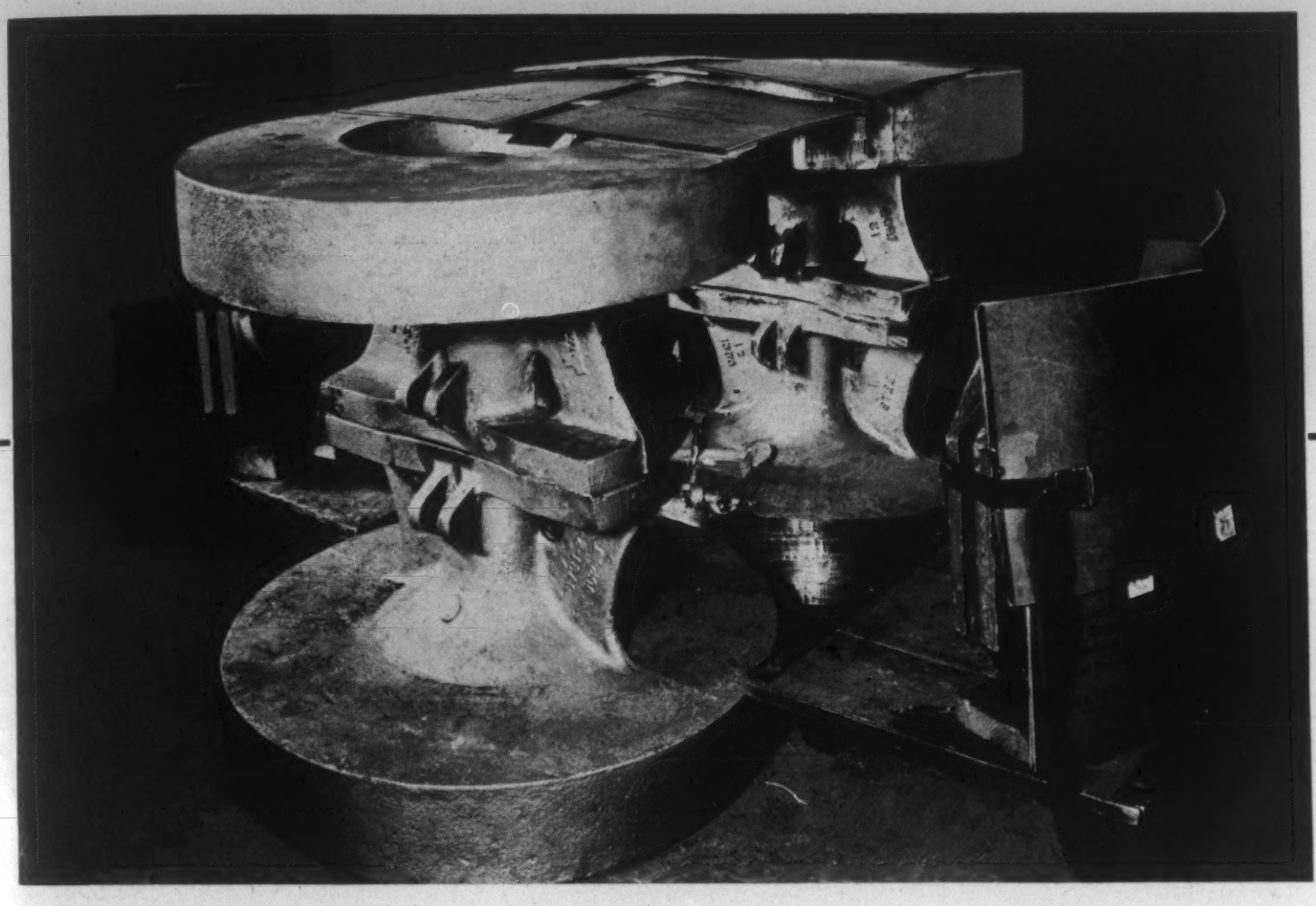
- - - it's available on request!

CATALOG F-241 contains descriptions and illustrations of Burrell High Temperature Box, Muffle, Pit and Tube Type Furnaces.

Data on automatic controls, high temperature combustion tubes, furnace pyrometers, tap transformers, sulfur removal apparatus, and sulfur-by-combustion apparatus is also included.

BURRELL
TECHNICAL SUPPLY CO.
1942 Fifth Ave. Pittsburgh, Pa.

RADIUM



Photograph, Courtesy Walworth Co.

*In the **RADIUM RADIOGRAPHY** set-up shown above, simultaneous exposures are being made with one radium capsule in critical areas of four 1800 lb. castings and four 350 lb. castings for use in high temperature and pressure steam service.*

RADIUM RADIOGRAPHY provides:

- Inexpensive non-destructive sub-surface inspection.
- A constant value, spontaneous, radiant energy source, which is completely portable.
- Simple operating technic requires no additional technical personnel and no supervision is necessary during exposure time.
- No expensive accessory equipment is necessary.

RADIUM CAPSULES OF VARIOUS UNIT STRENGTHS IN DURALUMIN HOLDERS MAY BE RENTED AT NEW LOW RATES WHICH INCLUDE FULL COVERAGE INSURANCE AGAINST LOSS. RADIUM MAY ALSO BE PURCHASED.

HEAVY LEAD STORAGE CONTAINERS AND SLIDE RULE EXPOSURE CALCULATORS ARE SUPPLIED WITH THE RADIUM AT NO ADDITIONAL COST.

Write for Details!

RADIUM CHEMICAL COMPANY, INC.

570 Lexington Ave., New York

Marshall Field Annex Bldg., Chicago

Commercial Pioneers In Industrial Radium Radiography

1.3 sec., it moves on and is replaced by the next one and so on. The first knife emerges from the inspection hood and, if defective, is ejected from the chain by a solenoid-actuated finger.

The apparatus is readily capable of examining 1,400 knives an hour. It has been operating successfully at the Oneida plant for a year. FPP (4)

Impact Testing

"Impact and Hardness Tests; Notes on Their Practical Use." Gordon T. Williams (Deere & Co.) *Metal Progress,* Vol. 39, May 1941, pp. 585-591. Review.

A "tough" metal is described as one that has "both high capacity to resist load and good capacity to deform." The greatest use of the notched bar impact test, commonly regarded as a means of measuring toughness of steel, is as a uniformity test.

The modern notch-impact testing machine uses a carefully prepared small square-section specimen. A heavy pendulum hammer is released from a certain height and strikes the specimen on reaching dead center, breaks it, swings on past, and rises to a height on the other side. This height is measured and compared with the height of a "free swing."

The difference is a measure of the amount of energy needed to break the sample. Depending on the type of test and specimen (Charpy or Izod), the results evaluate the effect of a notch of a certain shape on the energy absorbed by a 0.394-in. wide specimen broken by a quick blow.

The Izod test is the favorite in America, the Charpy in Europe. Un-notched square specimens ¼-in. square and 6 in. long broken in a Charpy fixture are used to study die castings, tool steels, etc., which, if notched, would have values below the accuracy of the reading.

Velocity of impact, actual room temperature, and particularly the shape of the notch all have an effect on the results. Extreme precision of shape and surface at the root of the notch is especially important. The keyhole (Charpy) notch is thus praiseworthy, because it permits easy drilling of a precise hole at a precise position.

As mentioned earlier, the notch bar test is most useful as a "check test." It is often helpful to compare Izod and Charpy test results on the same steel—if the steel itself is tough, the Izod value will be greater; if it verges on notch-brittleness, the reverse will be true. (4)

GAMMA RAY RADIOGRAPHY

detects blowholes, gas pockets, non-metallic substances, cracks, porosity, etc.

Radium ***is NECESSARY*** ***For Greatest Metal Thickness***

Radium ***is BEST*** ***For Weld Inspection***

Radium ***is PORTABLE***

Radium ***is INEXPENSIVE***

Radium ***is Available for SALE OR RENTAL***

Literature and Details on Request

CANADIAN RADIUM & URANIUM CORPORATION

630 FIFTH AVENUE, NEW YORK, N. Y.

The Reflecting Microscope for Slags

"Use of the Reflecting Microscope in the Examination of Open Hearth Slag." Michael Tenenbaum (Inland Steel Co.) & T. L. Joseph (Univ. Minn.) *Blast Furnace Steel Plant,* Vol. 29, Apr. 1941, pp. 403-407; May 1941, pp. 522-523, 545, 551-552. Investigation.

The reflecting microscope affords a simple and rapid method for the study of open-hearth slags. Suitable samples can be prepared in less than 5 min. Many of the minerals encountered in open hearth slag are readily recognized in reflected light once they have been identified by other means.

As a basis for this study, a large number of slags were examined both in transmitted and reflected light. The sections used for petrographic studies were taken vertically through the cake about ½ in. from the outer edge. The location of surface examined in reflected light was comparable to that of the thin section. Samples were ground and polished and those requiring etching were etched in a 0.5% HCl solution.

As few single heats pass through all the structural changes, samples were selected from a number of heats to illustrate how typical structural changes can be followed with the reflecting microscope. It was observed that early acid slags are acicular in microstructure and must be etched to be distinguished in reflected light. This acicular structure gradually disappears as the slag becomes more basic, and had disappeared when the lime-silica ratio of the slag exceeded 1.8.

Dicalcium silicate begins to appear in appreciable amounts as soon as the lime is up and begins to go into solution. It occurs as gray primary-appearing grains which usually exist in clusters. It exists first as a solid phase in the molten slag. As the slag matures, the number and size of these grains decrease, indicating its solution which is usually accompanied by a decrease in slag viscosity. On freezing, the liquid part of the slag appears as an inter-growth of the light oxides and ferrites together with the gray dicalcium silicate.

Mature slags have all the dicalcium silicate in solution and are composed entirely of the inter-growth structure, which indicates a slag with a lime-silica ratio in excess of 3.00.

FROM IZOD TO CHARPY TO TENSION IMPACT

"with a twist of the wrench!"

THE NEW

OLSEN IMPACT TESTER

WITH THE

"CHANGE-O-MATIC" HEAD

AN EXCLUSIVE OLSEN DEVELOPMENT

Izod to Charpy to Tension Impact with a twist of the wrench! No longer need you "set-up" for each test; no longer need you add or remove striking surfaces, anvils, etc. . . . merely loosen a lock screw and turn the exclusive CHANGE-O-MATIC HEAD to the desired testing tool surface. In addition, the new Olsen Impact Tester has a *completely automatic brake* . . . no button to push or level to pull. These are but two of the many features which make this the most completely modern Impact Testing Machine ever built . . . with operating simplicity and testing accuracy assured.

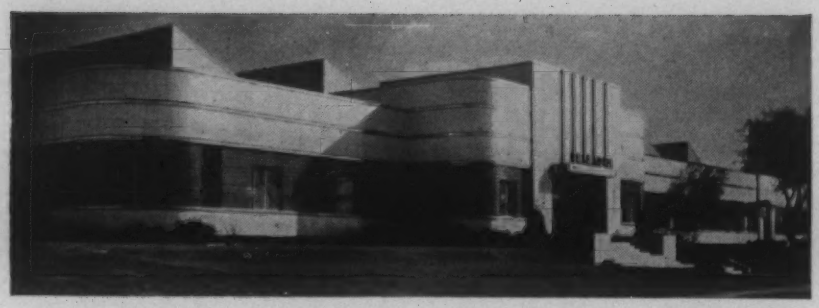
TINIUS OLSEN TESTING MACHINE CO.

500 N. TWELFTH ST.
PHILADELPHIA, PA.

Western Representative
PACIFIC SCIENTIFIC COMPANY
Los Angeles, San Francisco, Seattle

Proving every day that the value of testing depends on the quality of the testing equipment.

Get all the details on the new Olsen Impact Tester with CHANGE-O-MATIC HEAD. Write for Bulletin No. 22.



IN THE WORLD'S LARGEST PORCELAIN ENAMEL BUILDING

The new research laboratory of The American Rolling Mill Company at Middletown, Ohio, is "all-electric" and is said to be the world's largest porcelain enamel building.

Experimental heats of iron and steel are melted down in small Ajax-Northrup High Frequency Furnaces with current supplied by a 35 KVA Ajax-Northrup Converter.

For larger melts they use Ajax 250 and 500 lb. furnaces and a 100 KW high frequency motor generator.

Accurate control, flexibility and the fact that a large number of test melts can be made in a comparatively short time are the principal advantages of the Ajax-Northrup Furnace.

ASK FOR BULLETINS T-5 AND T-6.

Ajax-Northrup Melting Furnace Capacities: One To Eight Tons

AJAX ELECTROTHERMIC CORPORATION
AJAX PARK
TRENTON, N. J.

AJ-23-A

There's ever so much to see and do in

Baltimore!

Historic shrines, Maryland cooking, horse racing, yachting on the Chesapeake . . . and a hundred and one other fascinating attractions! The city's newest and largest hotel is located a short distance from everything you want to see . . . in the middle of the business, shopping and amusement districts.

700 ROOMS FROM $3

LORD BALTIMORE HOTEL

BALTIMORE, MARYLAND

TEMPERATURE

Its Measurement and Control in Science and Industry

THE PAPERS of the Symposium sponsored by the American Institute of Physics, with the cooperation of the National Bureau of Standards, National Research Council and a large group of officers and committees of many American scientific and technical societies with the following purposes in view:

1. coordination of the treatment of the subject of temperature in the several branches of science and engineering,
2. review of fundamental principles and a recapitulation of recent progress,
3. accumulation of contributions for a comprehensive text to be published after the Symposium,
4. improvement of technical curricula by making the latest information available.

Fundamental knowledge in the field of temperature and its measurement is exhaustively covered in this encyclopedic volume. The collection of 126 papers by eminent chemists, engineers, metallurgists, physicists, physicians and biologists, presents thoroughgoing descriptions of all phases of temperature technique, and profound theoretical treatment of the thermodynamics and physics which underlie the various temperature scales.

The scope of this volume is all-inclusive, ranging from the closest possible approach to absolute zero to the temperature of the stars; from the production and loss of heat in the body to measuring the temperature of volcanoes. Innumerable methods of precision pyrometry are described in detail. Low-temperature cancer therapy, cooling of massive concrete structures, temperature conditions in oil-well drilling, artificial fever, high-temperature arcs, molten steel pyrometry—these and many more subjects of compelling interest make this an essential reference work for laboratories and libraries, as well as for all who are engaged in any phase of temperature work.

Detailed Circular Mailed on Request

$11.00

1362 pages 550 illustrations

Reprints of the Standard Reference Tables found in the Appendix, flexible cover, $1.00 extra, per copy

Reinhold Publishing Corporation

330 West 42nd Street ■ New York, N. Y.

Tricalcium silicate and calcium ferrite can also be detected in reflected light. The former appears first as gray, lath-like grains and in more mature slags as long narrow needles. The least basic slag in which this constituent was observed had a lime-silica ratio of 3.1.

Calcium ferrite appears as short, white, needle-like grains within the intergrowth structure. The least basic slag in which it was observed had a lime-silica ratio of 2.6.

To permit closer association of slag structure and certain stages in the refining process, slag structures observed in a high and in a low carbon heat in reflected light are presented. MS (4)

Electrostatic Electron Microscope

THE ELECTROSTATIC ELECTRON SUPER-MICROSCOPE AND SOME NEW METALLURGICAL RESULTS ("Ueber das elektrostatische Elektronen-Ueber-mikroskop und einige neue Ergebnisse auf metallurgischem Gebiet") HANS MAHL. *Z. Metallkunde*, Vol. 33, Feb. 1941, pp. 68-73. Descriptive.

An electrostatic electron microscope is described, which employs as a "lens" an *electrostatic* field instead of the commonly-used *electro-magnetic* field. The resolving power obtained is 80 A.U.

In contradistinction to the magnetic-field microscope, a.c. may be used. Stereophotos can be made by taking a second picture after tilting the object through a small angle.

The oxide smokes from burning metals such as magnesium, iron, zinc and molybdenum were studied to determine particle size and shape. Differences in the composition of rust of different age and in comparison with freshly precipitated iron hydroxide were observed. The super-microscope seems to be particularly adapted to the study of surface films and a great number of photos are reproduced.

Thus, films on iron passivated in potassium-chromate solution are granular and the individual grains are identified as crystals. Surface oxide layers on heated iron are of uneven thickness and full of pores.

Films produced on aluminum by anodizing show no structure when of minute thickness, but become granular with increasing thickness. However, the grains are not of a crystalline nature, but "must be interpreted as variations in thickness (pores) occurring during the growth of the film." EF (4)

X-ray Stress Measurements on Aluminum Aircraft Alloys

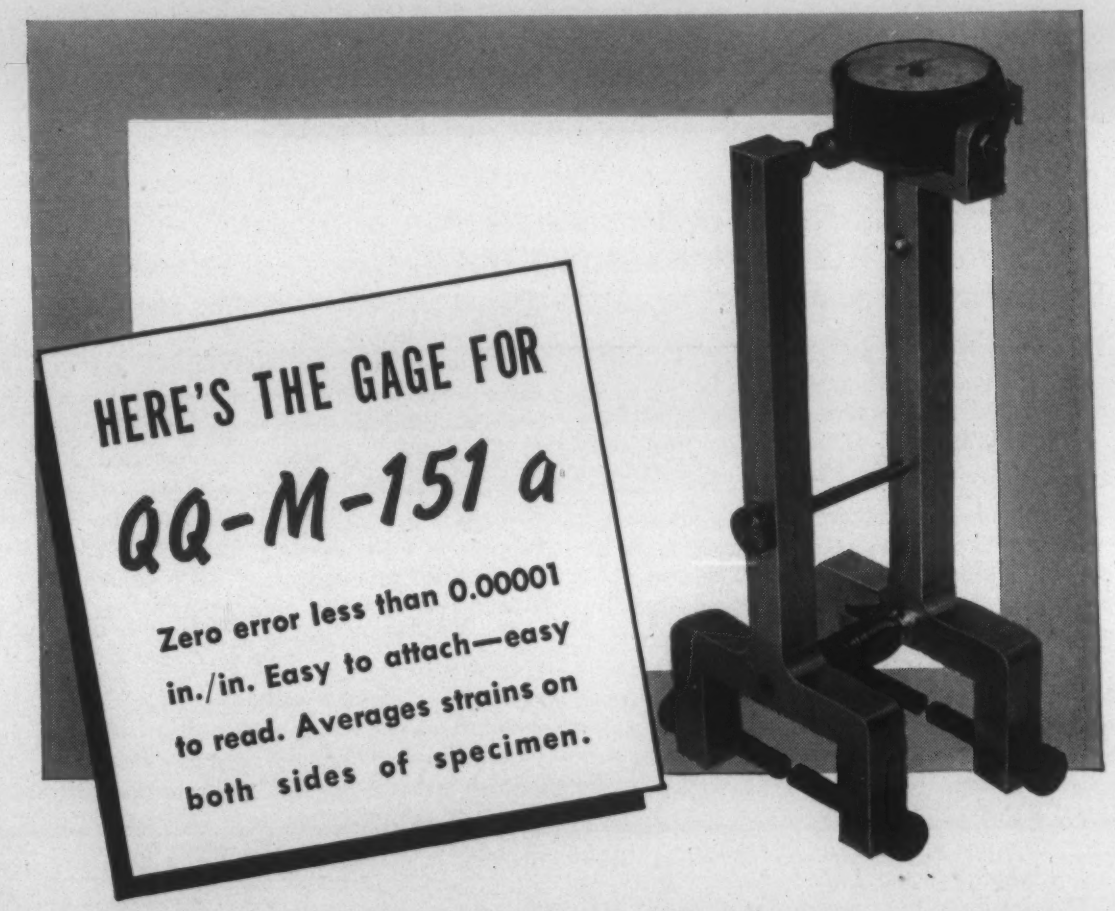
EXPERIENCE WITH THE APPLICATION OF X-RAY STRESS MEASUREMENTS FOR ALUMINUM ALLOYS IN THE CONSTRUCTION OF AIRPLANES ("Erfahrungen über die Anwendung von röntgenographischen Spannungsmessungen an Aluminiumlegierungen im Flugzeugbau") A. HENTSCH. *Aluminium*, Vol. 23, Jan. 1941, pp. 27-33. Review.

The X-ray method of determining internal stresses in a material and the quantitative evaluation of the X-ray exposures are explained and compared with the mechanical method of stress determination.

In general—and especially for small stresses—the latter method will be superior to the X-ray method. The reason is that in order to produce the patterns in such magnitude as to permit clear pictures and thus exact valuation, the material has to be homogeneous and free from precipitation, and its crystallites must form lattices with identical lattice constants.

The materials must also be isotropic, and the crystallites must not have a definite orientation, else the diffraction patterns will not be closed circles. The crystallites must not be distorted by stresses that are strongly changing locally, as this changes the lattice constant and broadens the diffraction lines. The material must have sufficiently fine grain.

For all these reasons, the coarse grain of the aluminum-copper-magnesium alloys used in airplane design, in conjunction with actual internal stress, produces only indistinct blackened spots. The X-ray method can even be used in such cases where strong locally-changing stresses are present; in such instances it is recommended to work with a slit diaphragm instead of a circular diaphragm. In any event, the X-ray method should be used only with great care, and after careful ascertainment that it will give good, evaluable exposures. Ha (4)


HERE'S THE GAGE FOR
QQ-M-151 a
Zero error less than 0.00001 in./in. Easy to attach—easy to read. Averages strains on both sides of specimen.

The H. F. Moore extensometer is ideal for determining yield strength, elastic limit and proof stress, as stipulated in Federal Specification QQ-M-151 a.

In addition to low zero error its large dial gage easily permits the reading of strains down to 0.00002 inch per inch of gage length. The gage is easily attached by screws which hold it firmly in position.

Adaptable to a wide variety of test pieces from 0.505 to 2 inches in thickness the H. F. Moore extensometer accurately averages strains on both sides of the specimen. Extension rods quickly convert it from 2-inch to 8-inch gage length. Write for Bulletin 153-A describing Southwark's line of strain gages and extensometers.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.

Baldwin Southwark
DIVISION OF THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA
BLW THE BALDWIN GROUP

books

Temperature and its Control

TEMPERATURE—ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY. *Published by Reinhold Publishing Corp., New York, 1941. Cloth, 6½ x 9¼ in., 1362 pages. Price $11.00.*

This book is the record of a "Symposium —held in New York, November 2, 3, and 4, 1939, under the auspices of the American Institute of Physics." Metallurgical engineers who are fortunate enough to have the now rare "Pyrometry" published by the A.I.M.E. in 1920, in which are collected the papers of the 1919 Symposium on Pyrometry will recognize the new book as having been cast to the same pattern, with some of the old metal as a strengthening alloy and with several of the old crew at the ladle.

The book is big, too big for detailed review, and contains considerable material of no direct metallurgical interest. The articles in Chapter 1 on Temperature and Temperature Scales are general. Chapter 2 on Precision Thermometry contains an excellent fundamental discussion of thermocouples by Wm. F. Roeser and a practical discussion of thermocouple-testing by Roeser and Wensel. The delightful article by Sosman in Chapter 3 on Education should be read by all who hire and train plant pyrometrists.

The discussions of Automatic Temperature Regulation and Recording comprising Chapter 7 are somewhat disappointing as the only instruments described are noncommercial laboratory devices intended for use under restricted conditions. All of the recorders described by Fairchild and Foote in the 1919 Symposium have been discontinued or changed beyond recognition. A discussion of modern instruments would be most welcome. In Chapter 8 (Special Applications and Methods), the article on flame temperatures is of special interest. Two papers on gas temperature measurement in Chapter 9 (General Engineering) are noteworthy.

Chapter 10 (Metals and Ceramic Industries), opens with an article by Sordahl and Sosman on The Measurement of Open Hearth Bath Temperature. After a summary of the difficulties and the methods previously used, a successful modification of the Collins-Oseland tube method is described. A steel tube inserted into the bath is kept open by a flow of air. Radiation from the bath passes up the tube to a blocking layer photoelectric cell, whose output is recorded. In regular steel plant service from eight to ten seconds are sufficient to take a reading.

Schofield and Grace describe the English "quick-immersion" technique for liquid steel in which a platinum couple sheathed in a thin silica tube is used. Fitterer describes the use of the carbon-silicon carbide couple with data from measurements on a Bessemer mixer. Chipman and Marshall report that the melting point of iron drops from 1535° C. to 1524° C. when the iron is saturated with oxygen. A brief paper by F. H. Norton on Pyrometry in Connection with Creep Tests, with discussion by Benz and Miller, Kanter, and McVetty manages to cover the high points, but leaves much unsaid.

There are also articles by Gardner on temperature measurement of red brass, and C. S. Smith on measurement of specific heat of metals. Two papers on pyrometric cones comprise the Ceramic section of the chapter.

Chapter 11 (Oil Industries) deals with production and refining. Hodell has an extremely interesting article on welding of oil-well casings. His statement that the maximum acceptable hardness of welds is 200 Brinell evoked a warm discussion when the paper was presented, but the discussion was not printed.

Chapter 12, (Optical and Radiation Pyrometry) contains fundamental articles by W. E. Forsythe on optical pyrometry, and by A. G. Worthing on emissivity, and practical contributions from several industrial laboratories.

Chapter 13 (Thermometric Metals and Alloys) has articles on the stability of base-metal and platinum termocouples, with much new and useful information.

The book closes with an appendix of tables of pyrometric data prepared by the National Bureau of Standards, a glossary of pyrometric terms assembled by C. O. Fairchild, and exhaustive author and subject indexes.

The volume has all the advantages and few of the faults of such collective effort. There is surprisingly little repetition and contradiction, although space is given to things of temporary value and some important subjects are inadequately covered. It is interesting and stimulating reading as a whole, and a necessary reference volume for all who believe there is more to measuring a temperature than just reading an instrument.

—H. W. RUSSELL

Tin Applications

TIN RESEARCH INSTITUTE, REPORT FOR 1940. *Published by Tin Research Institute (Pub. No. 103), England (In the United States: Battelle Memorial Institute, Columbus, O.) 1941. Paper, 6¼ x 7¾ in., 24 pages. Price: No charge to those interested.*

This report summarizes recent researches and development work on the uses of tin. Of chief importance has been the development of white bronze plating and the promotion of both electrotinning and hot tinning. Work has been in progress, also, on hardening tinned coatings, on soldering fluxes, on making tin-coated copper, lead and steel foil, and in developing a protective oxide film on tin plate that will resist sulphur staining on the inside of cans.

A special experimental tinning machine was operated in one of the English laboratories to demonstrate means for giving smoother, less porous coatings on tin plate. Weekly demonstrations were given in England on hot tinning procedures as an aid to manufacturers using various types of steel not normally tinned.

A publication on Hot Tinning, recently issued, is based on experience gained in such industrial problems, plus research at the laboratories. An investigation was also made on substitutes for palm oil and tallow in tinning work. Bearing metal research has been continued to develop improved tin base alloys for lining bearings, to secure improved adhesion, and to develop alloys which are more suitable for ships' underwater bearings.

B. W. GONSER

Metallographic Etching

METALLOGRAPHIC ETCHING (AETZHEFT) 3RD EDITION. *By Angelica Schrader. Published by Gebrueder Borntraeger, Berlin, 1941. Cardboard, 5¾ x 8¾ in., 28 pages. Price 1.60 RM.*

The manual, prepared by Angelica Schrader, of the *Atlas Metallographicus* team of Hanemann and Schrader, has been brought up to date by inclusion of useful reagents developed since the second edition appeared. Especial attention is given to recognition of carbides in steel and compounds in aluminum alloys.

H. W. GILLETT

(*Continued on page 122*)

A Selected list of Metallurgical books that may be of Service in helping to solve some of the serious problems in Our National Defense Program

BERYLLIUM: ITS PRODUCTION AND APPLICATION

Published by the Zentralstelle fur Wissenschaftlich-Technische Forschungsarbeiten des Siemens-Konzerns
Translated by R. Rimbach and A. J. Michel

"About two-thirds of the text is devoted to a consideration of the metallography and physical properties of Beryllium and its alloys. The remarkable mechanical characteristics of some of these are dealt with in detail and the subject of age hardening which has been investigated with the aid of X-rays is given prominence: this portion is well illustrated with photomicrographs, X-ray photographs, equilibrium diagrams and other diagrams showing changes in various electrical and mechanical properties following alteration in composition or treatment. The volume forms a mine of useful information . . . full of new facts about this interesting metal."—CHEMISTRY AND INDUSTRY.

CONTENTS: Introduction. Outline of the Research Program on the Production and Uses of Beryllium. The Analytical Chemistry of Beryllium. The Occurrence of Beryllium. The Thermal Reduction of Beryllium. Investigations on the Dressing of Raw Beryl and on the Production of Beryllium Salts Suitable for Electrolysis. Electrolytic Production of Beryllium. The Influence of Bath Composition and Bath Temperature on the Stock-Goldschmidt-Siemens & Halske Method for the Production of Beryllium. Physical and Chemical Properties of Beryllium. The Production of Electrolytic Deposits of Beryllium by High Temperature Electrolysis. Direct Electrolytic Production of Beryllium Alloys. The Structure of Beryllium-Copper Alloys. Physical Properties and Age Hardening of Beryllium-Copper Alloys. Changes in the Electrical Conductivity and the Volume During Age Hardening of Beryllium-Copper Alloys. The Changes in the Modulus of Elasticity During Age Hardening of Beryllium-Copper Alloys. Changes in the Microstructure of Beryllium-Copper Alloys Due to Age Hardening. X-ray Investigation of the Age Hardening Process in Beryllium-Copper Alloys. Theory of the Age Hardening Process Based on the Investigation of Beryllium-Copper Alloys. The Effect of Small Additions of Phosphorus on the Age Hardening of Beryllium-Cooper Alloys. Ternary Copper-Base Alloys Containing Beryllium. Beryllium-Nickel Alloys. Beryllium Iron Alloys. Magnetic Measurements of Iron-Beryllium Alloys. Aluminum-Beryllium Alloys with an Appendix on Silicon-Beryllium Alloys. ***331 pages, 198 figures $10.00.***

SILVER IN INDUSTRY

Edited by Lawrence Addicks
Consulting Engineer

Edited by Dr. Lawrence Addicks, eminent consulting engineer and former president of the Electrochemical Society, the book contains the work of thirty contributors, each of whom is particularly well qualified in the field on which he writes. The tremendous bibliography, containing over four thousand literature references, and a list of all the patents which have been issued on the industrial uses of silver are other valuable features of this interesting and timely volume.

CONTENTS: The Background—Lawrence Addicks, Properties of Silver—A. J. Dornblatt, Binary Silver Alloys—A. J. Dornblatt, Ternary and Engineering Alloys Containing Silver—A. J. Dornblatt and A. M. Setapen, Technology of Silver—A. J. Dornblatt, Low-temperature Bonding of Silver—Allison Butts and G. R. Van Duzee, High-temperature Bonding of Silver—R. H. Leach, The Use of Silver in Bearings—R. W. Dayton and C. L. Faust, Coatings—Lawrence Addicks and A. J. Dornblatt, Electroplated Silver Coatings—A. J. Dornblatt and A. C. Simon, Chemical and Vaporized Coatings—A. M. Setapen, Silver in Stationary Electrical Contacts—Lyall Zickrick, C. Peterson, and F. H. Clark, Silver in Moving Electrical Contacts—S. B. Wiltse and H. M. Parshall, Silver as a Catalyst—Allan R. Day and Tony Immediata, Corrosion Resistance of Silver and Silver Alloys—Allison Butts and J. M. Thomas, The Oligodynamic Effect of Silver—A. Goetz, R. L. Tracy, and F. S. Harris, Jr., Silver as a Fungicide—L. W. Nielson and L. M. Massey, Miscellaneous—Lawrence Addicks and Irl C. Schoonover, Statistics of Industrial Consumption—Lawrence Addicks, Summary and Conclusions—Lawrence Addicks, Appendix I. Bibliography. Appendix II. Patent Index. Subject Index.

636 pages, profusely Illustrated. . . .$10.00

SAMPLING AND ANALYSIS OF CARBON AND ALLOY STEELS

Prepared by the Chemists' Committee of the Subsidiary Companies of the United States Steel Corporation.

Exact chemical specifications govern the manufacture and purchase of steel products.
The scope of this book includes approved procedures for sampling mill products, and for determining all the elements that may occur in steel under any conditions of combination. Methods are given for such infrequently occurring elements as beryllium and cerium. The first appendix article describes three recent new procedures for determination of sulphur by combustion, most desirable when it is impossible to obtain the sulphur content by older methods.

CONTENTS: Sampling. Qualitative and Quick Tests for Identifying Various Types of Steel. Methods of Analysis. Chemical Separations. Determination of Manganese. Determination of Phosphorus. Determination of Sulphur. Determination of Silicon. Determination of Copper. Determination of Nickel. Determination of Chromium. Determination of Vanadium. Determination of Molybdenum. Determination of Titanium. Determination of Aluminum. Determination of Arsenic. Determination of Tin. Determination of Cobalt. Determination of Tungsten. Determination of Uranium. Determination of Zirconium. Determination of Columbium and Tantalum. Determination of Selenium. Determination of Boron. Determination of Beryllium. Determination of Nitrogen. Determination of Antimony, Copper and Molybdenum. Determination of Zinc. Determination of Cerium. Appendices—1. Determination of Sulphur or Carbon and Sulphur by Combustion in Oxygen. 2. Discussion of Methods for Oxygen, or Oxygen, Hydrogen and Nitrogen in Steel. 3. Preparation, pH Ranges, and Color Changes of Various Organic Chemical Indicators. 4. Table of Atomic Weights, Atomic Numbers, and Other Physical Constants of the Chemical Elements.

356 pages, 20 figures. $4.50

TIN

Its Mining, Production, Technology and Applications
by C. L. Mantell, Ph.D.

CONTENTS: History. Physical and Chemical Properties of Metal. Production, Distribution and Consumption. Ores and Ore Deposits. Mining and Ore Dressing. Smelting and Metallurgy. Gaseous Reduction. Electrolytic Refining. Planting. Alloys. Hot Dipped Coatings. Foil and Collapsible Tubes. Compounds. Corrosion. Corrosion of Tin Plate by Food Products. Secondary Tin. Detinning of Tin Plate Scrap. Analytical Methods. Index.

366 pages, 91 figures. $5.25

American Chemical Society Monograph, No. 51

REINHOLD PUBLISHING CORPORATION, 330 W. 42nd St., New York, N. Y.

Fatigue of Metals in Design

PREVENTION OF THE FAILURE OF METALS UNDER REPEATED STRESS. *By the Staff of Battelle Memorial Institute. Published by John Wiley & Sons, Inc., New York, 1941. Cloth, 6¼ x 9¼ in., 273 pages. Price $2.75.*

Modern knowledge of "fatigue" of metals as an engineering factor has been progressing so rapidly that it has outstripped the writing of manuals on the subject. The latest work on fatigue of metals in the English language was published in 1927 and even when this has been supplemented by summaries of present day knowledge of fatigue of metals in the reports of the Fatigue of Metals Committee of the American Society for Testing Materials and by the 1933 Marburg Lecture delivered before that Society by Dr. H. J. Gough, the picture is still incomplete.

In no branch of engineering construction and operation is the problem of failure by fatigue of metals under repeated stress more serious than in the aircraft industry. In 1939 the Bureau of Aeronautics of the U. S. Navy Department asked the cooperation of the National Research Council in considering fatigue of metals problems, and in response to this request a Conference of various workers in this field was held. It was decided to request Dr. H. W. Gillett of Battelle Memorial Institute to prepare a manual especially for the use of the U. S. Navy Department, and in that manual to emphasize the dangers of fatigue failure and to show illustrations of various types of fatigue failure, especially in aircraft service. This manual has been prepared by the staff of Battelle, under the title noted above.

It is a major contribution to our knowledge of fatigue of metals. First of all it is a strong presentation of the dangers and of the types of failure which may be caused by repeated stress, and, especially, the dangers of faulty design, bad steel, faulty machining, and damage in service. Over 70 photographs of typical fatigue failures are shown.

However, it is much more than this. It not only illustrates the types of fatigue damage but gives in its first part of the manual a concise discussion of fatigue testing and of stress concentrations. The vital importance of localized stress in fatigue problems as compared with its minor importance in problems of static stress is emphasized and re-emphasized with vivid illustrations. From this part of the book, alone, the designer and builder of aircraft or airplane parts should be made thoroughly aware of the extreme danger of notches, holes, screw threads, key ways, and sharp fillets in regions under repeated high stress.

There then follow 28 appendices taking up in further detail special features which were mentioned in the first part of the manual. These appendices include such subjects as the discarded notion of "crystallization" as the effect of fatigue, the effect of temperature, geometric factors and size effect, methods of mitigating stress concentration, the effect of cold work, the effect of surface conditions and of surface coatings, the effect of corrosion with and without accompanying stress, and effect of internal crystalline structure. These appendices form an excellent survey of our present state of knowledge of fatigue of metals.

However, the book does not stop here. For those whose appetite is whetted for still further study, the book gives 446 references to special studies and investigations. Starting with this book, and with a reasonably good technical library available, it should be possible for the designer and the shop foreman to get an up-to-date education in the problems of fatigue of metals.

The book is one which should be in every designing office and in the personal library of every ambitious machine designer. It should, naturally, be in the library of every engineering school. Its unusual use of many appendices makes it useful as a reliable guide for quick reading when any special problem in fatigue of metals is encountered.

—H. F. MOORE

Corrosion Protection

CORROSION OF METALLIC MATERIALS. VOL. 3—PROTECTION AGAINST CORROSION *(Die Korrosion Metallischer Werkstoffe—Band 3) By O. Bauer, O. Kröhnke & G. Masing. Published by S. Hirzel, Leipzig, 1940. Cloth, 6¾ x 9½ in., 615 pages. $17.00.*

To charge $17.00 for this book is just highway robbery. Even if one has the two previous volumes and hence would normally be inclined to complete the set, he had better keep his money.

A few fundamentals and platitudes are given on a vast variety of subjects, without going far enough to be very useful on any. Among the topics thus skimmed over are pickling, degreasing, oil paints and varnishes, cellulose ester varnishes, bituminous coatings, the polymerized organic coatings, enamels, phosphate coatings, metal coloring, electrolytic coatings, hot dipped coatings, and electrolytic oxide coatings.

Better and more comprehensive texts exist on practically everything covered, and the price of this book will buy several of these.

—H. W. GILLETT.

Armament Contracts, Specifications

ARMAMENT PRODUCTION POLICIES. *(A record of a forum held by the New York Post of the Army Ordnance Assn.) Published by Reinhold Publishing Corp., New York, 1941. Paper, 8½ x 11 in., 57 pages. Price $1.00.*

By question and answer there are clarified some of the problems connected with government bids, tax provisions on government contracts, government aid for plant facilities, financial assistance, types of government contracts and labor provisions in them.

This is chiefly for the benefit of potential contractors and subcontractors. A question as to the use of commercially standard materials instead of War Dept. specifications and tests was answered by stating that the Ordnance Dept. may "accept the chemical analyses and physical tests that any reputable firm has normally asked its supplier to furnish" and that "the arsenals are looking very sympathetically upon substitution of steels" whose composition "might be considered more commercial than a War Dept. specification."

Citation of this might serve to let a bidder open up the matter of substitution of usable materials for those specified but not now available.

—H. W. GILLETT.

Other New Books

AIRCRAFT TUBING DATA. *Edited by J. E. Younger. Published by Summerill Tubing Co., Bridgeport, Pa., 1941. Fibre, with wire binder, 9¾ x 11½ in., 144 pages. Price $1.50.* Covers manufacture, specifications, heat-treating charts, welding, magnaflux inspection, tube bending, corrosion protection, properties, etc. The treatment of welding and of magnaflux inspection problems is especially noteworthy. Most of the data refer to X4130 tubing.

SELECT BIBLIOGRAPHY ON THE PRODUCTION OF STEEL SHEETS AND STRIP. PART III. *Published as Research Bulletin No. 5 by Sheffield City Libraries, Sheffield, England, 1941. Paper, 8 x 10 in., 24 pages. Price 3 pence.* This is the concluding part of a 3-part bibliography issued in instalments during the last few years.

HANDBOOK OF WELDED STEEL TUBING. *Published by Formed Steel Tube Institute, Cleveland, 1941. Flexible looseleaf binding, 5½ x 8¾ in., 86 pages. Price $1.00.* A highly useful reference book for design engineers and other users of welded carbon and alloy steel tubing.

TRADE-NAMES INDEX. *Published by Special Libraries Association, New York, 1941. Cloth, 7¼ x 10¼ in., 178 pages. Price $4.00, plus postage.* Definitions of materials, processes and equipment of industrial significance, indexed by trade-names. In general, gives many names not found in conventional sources such as Thomas' Register, MacRae's Blue Book, etc.; such sources are listed in an appendix. Metallurgical engineers may find this a useful supplement to Woldman and Dornblatt's "Engineering Alloys."

1940 SUPPLEMENT TO A.S.T.M. STANDARDS—PART I, METALS. *Published by American Society for Testing Materials, Philadelphia, 1940. Cloth, 6¼ x 9¼ in., 478 pages. Price $3.00.* These supplements are issued each year between the triennial publication years of the big book of standards, to keep the latter up-to-date. This supplement, with 100 standards, includes 48 specifications on ferrous metals, 49 on nonferrous and 3 on general testing methods.

GOLD—PART 3 OF "METALLIC RAW MATERIALS, THEIR DISTRIBUTION AND ECONOMIC IMPORTANCE" (Die Metallischen Rohstoffe, ihre Lagerungsverhältnisse and ihre wirtschaftliche Bedeutung. 3—Heft—Das Gold) BY GEORG BERG & FERDINAND FRIEDENSBURG. Published by *Enke Verlag, Stuttgart W., Germany, 1940. Paper 6½ x 10 in., 248 pages. Price 20 RM.* The geology and mineral economics of gold are exhaustively covered.

PHOSPHATE COATINGS FOR RUST RESISTANCE (DER PHOSPHATROSTSCHUTZ). *By Oswaldo Macchia. Published by Verlag Chemie, Berlin, 1940. Cloth, 6¼ x 8½ in., 250 pages. Price 12 RM.* A German translation of the very good Italian original, published in 1938 and reviewed in METALS AND ALLOYS, Vol. 10, Jan. 1939, p. MA 62.

LOW CURIE POINT ALLOYS. *Published by Utilities Coordinated Research, Inc., New York, 1940. Fibre 9 x 11½ in., 57 pages. Price $1.00.* A report of research done at Battelle Memorial Institute.

REPORT OF COMMITTEE ON METALLURGICAL APPLICATIONS OF ELECTRICITY. *By C. F. Hirshfeld. Published by Utilities Coordinated Research, Inc., New York, 1940. Fibre, 9 x 11½ in., 94 pages. Price $1.00.* A report of work done at Battelle Memorial Institute for UCR.

Just a doggone good idea for flagging down steel buyers who have an eye for fine stock and good performance.

Maybe we've got our analogies mixed, but we're not in the least confused when we say that TIMKEN Alloy Steels are made of the finest materials available and their consistently good machining, forging and wearing qualities are unsurpassed.

Why buy less than the best steel when its cost is such a small part of the finished product? Consult us today.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
Steel and Tube Division

TIMKEN
ALLOY STEELS

trends

By Edwin F. Cone, Editor

Standard Alloy Steels

The trend toward the standardization of alloy steels to increase efficiency (other than the tool, stainless, heat-resisting and "low or mild alloy") which has been agitated for some time, has taken definite shape in the promulgation by the general technical committee of the American Iron and Steel Institute of a new list comprising only 76 standard alloy steels. This standardization is intended to reduce the unnecessarily wide range of specifications. In 1940 about 96 per cent of the total output of tonnage alloy steels was covered by only 55 varieties.

The undertaking was discussed editorially in METALS AND ALLOYS in August 1940, page 139.

Now come revised standards of the S. A. E. steels—eliminating 25 former carbon and alloy standards, the new total being 84.

The trend is in the right direction, though one that could easily go too far. But why two sets of standards?

Metal Prices

Some striking results are obtained if metal prices now (April) and quotations in April, 1917, are compared. The trend thus far is not toward the heights of the other war. For example: Copper in 1917 was 31c a lb. as compared with 12c in April, 1940; zinc was 10c against 7.25c now; aluminum was 59c then while now it is 17c a lb., with magnesium $2.25 as compared with 27c during this war. The relative comparisons hold for tin, lead, nickel, bismuth, and cadmium, but quicksilver and tungsten ore are now higher than in 1917.

Converters for Steel Castings

After about 25 yrs. of a trend towards the elimination of the side-blow converter for steel castings, there is now an expansion in demand for this melting unit. There were approximately 100 converters in operation in steel foundries in this country 25 yrs. ago. The most recent data show 16 in the United States and 3 in Canada. Recent sales, however, will increase this number by 4 or 5. These data are on the authority of a paper before the A. F. A. convention in May by Gregg and Skeates who offer reasons for the probable comeback of this melting unit.

More Electric Steel

When the A. M. Byers Co. of Pittsburgh puts into operation its new electric furnace equipment about June 15, the country's output is expected to be increased by 30,000 to 40,000 tons per yr., mostly as billets and bars. This pioneer maker of wrought iron is entering a new field.

Another conspicuous example of the upward trend in demand for electric steel is the initial operation of a 65-ton electric arc furnace by the Timken Roller Bearing Co., Canton, Ohio. This new furnace brings the company's electric furnace capacity up to 360,000 ton per yr. It supplements the famed 85-ton oval shaped furnace which has been in production nearly 15 yrs. Other furnaces in the battery are one 60-ton, 2 of 35-ton capacity and one of 20-ton—7 in all.

"Insurance Research"

Immediate and correct answers to substitution problems are very difficult, said a speaker in an address recently before a technical convention, unless there has been prior thought and experiment given them. "Those firms that have given thought to the problems and have already carried out what we might term 'insurance research' are not particularly flustered by present conditions."

Manganese Supplies

In 1941 alone this country's vast steel output will need 1,000,000 tons of high-grade manganese ore or its equivalent. From domestic ores and Cuba we can get one-third of this and (with the necessity for extensive plant construction) domestic low-grade ores could ultimately be utilized for the balance.

Lower Tin Consumption

The U. S. Bureau of Mines has stated that a 25 per cent reduction in tin consumption could be made without particular hardship. By changing to known substitute materials, in an "all-out" effort to get along without tin, other authorities estimate that the country could get along with a 75 per cent reduction, and that thus Bolivian tin would suffice for most non-substitutable needs. This would mean a hardship during the transition period.

Molybdenum

Due to drastic curtailment of exports of molybdenum concentrates, the production of molybdenum again declined in 1940, according to the U. S. Bureau of Mines. Increased demand from domestic sources did not offset the falling off in exports. Domestic output last year was 33,128 net tons of concentrates containing 34,313,000 lbs. of Mo as against 32,347 tons in 1939 containing 30,324,000 lbs. The 1938 data are 36,157 tons and 33,297,000 lbs. respectively. Exports of molybdenum in 1940 were 12,677,794 lbs.—those for 1939 were 43,554,310 lbs.

Ferromanganese and Spiegel

The largest recorded output by American blast and electric furnaces of ferromanganese and spiegeleisen was made was 577,675 tons in 1937. For the first time the total in 1940 at 746,896 net tons. The largest previous total spiegeleisen output is made public—236,820 tons last year.

(Additional "Trends" on page 128)

Required

STEADY OUTPUT
LARGE CAPACITY
EXTRA SERVICE LIFE

You Know What You're Getting in Meehanite

Specified .MEEHANITE CASTINGS

In this coal screening and preparation plant (150 tons per hour capacity), built by Kanawha Manufacturing Company, Charleston, W. Va., 19 tons of Meehanite Castings contribute their *extra* wear resistance, strength, and dependability to these parts:

1. Gears and Sprockets
2. Conveyor Buttons (about 600)
3. Pillow Blocks
4. Connecting Rod Ends
5. Takeup Bearings

MEEHANITE Castings are manufactured by processes which permit accurate control of all their physical properties,—can be poured to *your* specifications,—help you solve design, production, and maintenance problems.

Write for
Meehanite Bulletin No. 12
"DESIGN WITH CONFIDENCE"

MEEHANITE RESEARCH INSTITUTE

311 ROSS STREET • PITTSBURGH, PA.

Take Your Casting Problems to a Meehanite Foundry!

Ansonia, Conn.	Farrel-Birmingham Co., Inc.
Bethayres, Pa.	H. W. Butterworth & Sons Co.
Bridgewater, Mass.	The Henry Perkins Co.
Buffalo, N. Y.	Pohlman Foundry Co., Inc.
Charleston, W. Va.	Kanawha Manufacturing Co.
Chattanooga, Tenn.	Ross-Meehan Foundries
Chicago, Ill.	Greenlee Foundry Company
Cincinnati, Ohio	Cincinnati Grinders Incorporated
Cincinnati, Ohio	The Cincinnati Milling Machine Co.
Cleveland, Ohio	Fulton Foundry & Machine Co.
Denver, Colo.	The Stearns-Roger Mfg. Co.
Detroit, Mich.	Atlas Foundry Co.
Flint, Mich.	General Foundry & Mfg. Company
Hamilton, Ohio	Hamilton Foundry & Machine Co.
Irvington, N. J.	Barnett Foundry & Machine Co.
Los Angeles, Calif.	Kinney Iron Works
Milwaukee, Wis.	Koehring Company
Mt. Vernon, Ohio, Grove City, Pa.	Cooper-Bessemer Corporation
New York, N. Y.	The American Brake Shoe & Foundry Co.
Oakland, Calif.	Vulcan Foundry Company
Orillia, Canada	E. Long, Ltd.
Philadelphia, Pa.	Florence Pipe Foundry & Machine Co., (R. D. Wood Company, Selling Agents)
Phillipsburg, N. J.	Warren Foundry & Pipe Corp.
Pittsburgh, Pa.	Meehanite Metal Corporation
Pittsburgh, Pa.	Rosedale Foundry & Machine Co.
Rochester, N. Y.	American Laundry Machinery Co.
St. Louis, Mo.	Banner Iron Works
St. Paul, Minn.	Valley Iron Works
London, Eng.	The International Meehanite Metal Co., Ltd.
Waterloo, N. S. W.	Australian Meehanite Metal Co., Ltd.
Johannesburg, South Africa	Meehanite Metal Co. (S.A.) (Pty.) Ltd.

trends

By Edwin F. Cone, Editor

More Bessemer Steel

There is some probability that the average size of the Bessemer converter will be expanded to at least 50-ton capacity. This will mean increased steel output, much needed for Defense. For certain applications Bessemer steel is satisfactory. In 1940 about 3.7 million tons of ingots and castings out of a total of about 67 million tons were made. For 1941 an estimate of 15 million tons of Bessemer out of a total up to 85 million tons has been made, if the capacity is increased and old converters are brought into production.

The Cr-Mn Stainless Steels

Because of the situation in nickel, there are indications that some companies are turning to the limited production and use of a stainless steel in which manganese replaces all or part of the nickel in the 18 and 8 type, with a decrease in the chromium content. This is not a new product and its value has been indicated for a part of the present uses of stainless both in this country and in Germany. Though manganese is a strategic metal as well as nickel, there is a possibility that the Cr-Mn type of stainless steels may come into some use for certain applications.

Most Popular Alloy Steel

An interesting and valuable trend in the gathering and study of statistics is one recently completed by the American Iron and Steel Institute. As the result of a painstaking search of the alloy steel industry, it has been found that alloy steel No. 4615 (S. A. E. 4615) wins the title of the most popular tonnage steel in 1940. Users ordered a greater tonnage of this particular steel than of any other produced in large quantities. It is Ni-Mo steel. In this analysis, stainless and heat resisting steels, tool steels, and the low-alloy high strength steels were not included in the popularity test. The trend toward the increased use of 4615 is emphasized by the fact that in 1938 and 1939, this steel stood only eleventh in rank. In those years the most popular steel was No. 3140, a Cr-Ni steel. This steel stood third in 1940. In each of the past 3 yrs. steel No. 52100 ranked second, a high carbon chromium steel.

Better Quality Steel

Answering the question—"What Improvements in Quality and Production of Steel Have Been Made since World War I?"—S. J. Cort, gen. mgr., Maryland Plant, Bethlehem Steel Co., said there have been two outstanding developments in the open hearth: Slag and oxidation control, and improvements in furnace design and control. "We have gotten away from the rule of thumb and have put into the hands of the furnace operator essential knowledge of thermal, chemical and physical phases of the steel-making operation, in sufficient time to make it useful in controlling the succeeding operations, and with these controls, he can accurately predict the desired results rather than hold a post-mortem."

Blast Furnace Linings

Improvements in the materials going into the lining of a blast furnace have been so important over a period of years that these linings have a much longer life, said W. A. Haven, vice president, Arthur G. McKee & Co. at the general meeting of the A. I. S. I. In 1880 a run of 105,000 tons was claimed a world's record. At the turn of the century 500,000 tons was deemed satisfactory. In 1920 the average life was probably about 750,000 tons and the record close to 1,500,000 tons. In 1940 and 1941 furnace after furnace is reported to have made more than 1,500,000 tons and several more than 2,000,000 tons and still going strong.

Plastics and Steel

Answering the question—"What Effect are Plastics Going to Have on the Steel Industry?"—L. H. Underwood, assistant to the vice president, of the Youngstown Sheet & Tube Co., said this can include only the near future, at the May meeting of the A. I. S. I. "The conclusion we must make today is that the steel industry is the gainer by the advent of plastics and will continue to be, as far as we can now visualize plastics progress." Every pound of plastics produced, of whatever kind, is a consumer of steel in the equipment used.

Multiple Alloy Steels

More multiple alloy steels are now being used for at least three reasons, according to Earl C. Smith, chief metallurgist, Republic Steel Corp., at the recent meeting of the A. I. S. I. These reasons are: (1) Producing steels to British requirements involving multiple alloys differing from our steels; (2) producing large quantities of multiple alloy steels for our Defense Program; (3) engaging in sweeping changes of composition to relieve nickel shortage.

Manganese Ore

General imports of manganese ore, so vital to the entire American steel industry, are practically maintaining the large volume recorded in 1940. These imports, according to the U. S. Bureau of Mines, comprise ore received, part of which went into immediate consumption and the rest entered bonded warehouses.

For the first quarter of 1941, the volume imported has been at the rate of 104,590 gross tons per month, which compares with 105,662 tons each month in 1940. None is coming from the U. S. S. R. which until late last year was sending at least 15,000 tons per month.